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for Information Technologies
in Education

ICT in Primary Education

Analytical Survey. Volume 3
Collective Case Study of Promising Practices

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Analytical survey

Volume 3
Collective Case Study of Promising Practices

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Foreword

The UNESCO IITE Analytical Survey Volume 3 subtitled Collective Case Study of Promising Practices illustrates how ICT can reshape the teaching and learning processes of children in primary education.

The ICT in Primary Education Analytical survey was initiated by the UNESCO IITE in 2011 within its international project. The first Volume of the Analytical Survey, namely Exploring the Origins, Settings and Initiatives was published in 2012 and was focused on the research literature review, a brief overview of the nine sample primary schools, an international review of various ICT in primary school strategies, and an international collection of inspiring projects and initiatives. In the second Volume of the Analytical Survey (published in 2014) namely Policy, Practices, and Recommendations the team of authors have focused more on what schools are doing. Each chapter of the Volume 2 is supplemented by dozens of sophisticated and real experience examples from the sample primary schools all around the world.

Following the intention to better understand the phenomenon of ICT in the first stage of institutional compulsory education the present analytical study published in Volume 3 describes five bright case studies from Singapore, Russian Federation, Mexico, Slovakia and Canada with good examples and innovative approaches to infrastructure development, curriculum design and ICT teacher competencies development. The publication contains a basis for future study and research in the projects on ICT in Primary Education and also will help education practitioners to make their decisions based on a number of educational good practices collected, described, analyzed and concluded in the present report as well as in all three Volumes of the Analytical survey ICT in primary education.

On behalf of the UNESCO IITE I have a great pleasure to thank all national and international experts who prepared and provided materials for present report as well as for all Volumes of the Analytical Survey ICT in Primary education, and express the hope for further cooperation within the framework of project on ICT in Primary education.

Dendev Badarch,
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Chapter 1 Collective

Case Study of Promising Practices

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Introduction

This collective case study describes and analyzes the promising ICT-enhanced teaching and learning practices of five primary schools in different regions of the world. Each case study provides a rich description of the context in which ICT has been used to meet curriculum outcomes and engage students in the development of 21st century competencies. By linking the practices in the studied schools with particular ICT-enhanced teaching and learning activities and supporting conditions, this chapter shows a detailed account of how successful the practices are, what the participants have done to make them successful locally, and what challenges they encountered in the process. Real-world case studies such as this are critical to understanding how ICT can be used to enhance learning outcomes, and will contribute to and expand the repertoire of knowledge about ICT in primary education to better inform practices and policies.

Theoretical Framework

The collective case study is framed using activity theory in order to account for the mechanisms that link the use of ICT for teaching and learning to their sociocultural settings. Activity theory may be used to analyze successes, failures, and contradictions in complex situations, as in most ICT-mediated learning environments, without reductionist simplifications (Engeström & Escalante, 1996; Korpela, Mursu, & Soriyan, 2002). From the activity theory perspective, ICT does not simply develop knowledge, skills, and dispositions of students; rather, it is a mediational tool to develop them. This perspective highlights how participants encounter ICT as mediational tools incorporated within suitably rich sociocultural settings of activities where the structure of the activities is the unit of analysis.

The Mediated Learning Model

This study examines the situation of ICT in the learning environment by taking ICT as a set of mediational tools for teaching and learning using the mediated learning model (Gifford, 1997). The mediated learning model identifies an activity structure that consists of four interactive components – teachers, students, non-ICT tools, and ICT tools. In this model, teachers re-conceptualize the nature of teaching and learning activities mediated by ICT in order to support their students to take the concepts and ideas of the subject, which appear initially as part of the shared discourse in the learning environment, and to internalise those concepts and ideas by way of appropriating them.

The model may be conceived as making up the zones of proximal development (ZPD) through which students can navigate with the aid of a supporting context, where the teacher is the mediator who provides guidance, strategic support, and assistance for students to appropriate the common discourse of the ICT-mediated learning activity (Moll, Tapia, & Whitmore, 1993; Vygotsky, 1978). At the same time, the teacher constantly "tests the water to see whether students can move to a new level of self-regulation" (Wertsch, 1991, p.113). Nothing is unidirectional in such an interactive model. Based on this model, the effectiveness of ICT for teaching and learning depends on the way those technologies are situated within the learning environment, as well as on the design of the environment. In this study, the mediated learning model is used to examine how ICT has been used in the learning environment for students to develop the subject knowledge, skills, and dispositions.

Culture as Garden Metaphor and the Sociocultural Settings

Although the mediated learning model captures the ICT-mediated activities in the learning environment, it does not account for the broader context in which the teaching and learning activities are situated. Hence, Cole's (1995) culture as garden metaphor is adopted in this collective case study. Culture and garden share a basic idea about creating an artificial environment with optimal conditions for growth of young organisms, mediated by tools and other organisms. Just like the garden that is dependent on the larger ecological system within which it is embedded, a change of culture in the broader context, such as a switch of school setting, is likely to impact the ICT-mediated teaching and learning activities in the classroom.

Applying this 'concentric' model to the collective case study, successive circles represent the broader contexts of the learning environment. The interacting components of the mediated learning model are in the innermost circle. The next circle contains the subject course, including elements such as curriculum and assessment modes, and department staff roles. The next level up is the school, where elements considered include the type, location, ethos of the school, ICT facilities, type of students, and time-tabling of ICT and non-ICT lessons. The country's education system is in the next circle, with elements such as education policies on the use of ICT, as well as recruitment and professional development of teachers. The outermost circle is the society at large in the country and consists of elements such as ICT use, ICT infrastructure, and expectations of parents and employers. The mediated learning model situated within the 'concentric' model provides this collective case study with a pair of theoretical lens to examine the ICT-enhanced teaching and learning activities in-situ, and to identify sociocultural dimensions that support these activities.

Background of Collective Case Study

The collective case study is part of a larger study on ICT in primary education that is initiated by IITE, UNESCO Institute for Information Technologies in Education. In 2011, IITE established an international team of nine UNESCO experts with the goal of conducting a long-term study on how ICT is reshaping the teaching and learning processes of children in primary education. The collective case study involves five primary schools from around the world; they are:

- Beacon Primary School in Singapore: Beacon Primary School is a government school situated in a typical working class neighbourhood in the western part of Singapore. It started operations in 2008 and its first cohort of students has just completed their six years of primary school education in 2013. Beacon Primary is one of the eight future schools under the FutureSchools@Singapore initiative.

- State Financed Educational Institution (SFEI) Educational Center (EC) "Educational Technologies" in Moscow, Russia: Located in Moscow, the SFEI EC "Educational Technologies" was established in 2003 as a structural subdivision of the Center for Information Technologies and Training Equipment. The main purpose of the subdivision is to provide continuous access to quality education and active social inclusion for children with disabilities using ICT and distance-learning technologies. SFEI EC "Educational Technologies" was registered on October 26, 2005, as an independent educational institution. It provides primary, basic, and upper secondary education, as well as a broad range of additional educational services.

- The American Institute of Monterrey (AIM) in Monterrey, Mexico: The school was founded in 1968 in the city of Monterrey, Mexico, as a private bilingual (English-Spanish) educational institution serving a primarily Mexican student population. AIM is housed on two different campuses, with the San Pedro Campus serving students from preschool to third grade, and the Santa Catarina Campus serving students from fourth to ninth grade.

- Primary and Lower Secondary School Bošany in Bošany, Slovakia: The school in Bošany is a state school situated in the central part of Slovakia, about 140 kilometres from the capital, Bratislava. Bošany is the second largest village in the Partizanske district, with a population of 4,300 people. Besides serving for the people in Bošany, the school is a catchment school for two neighbouring smaller villages as well. The whole district has a relatively high rate of unemployment (over 12%), which influences the social status of its inhabitants.

- The Saint-André School in Quebec, Canada: This primary school is located in Granby, a small city in Quebec, Canada, 100 km East of Montreal, with a population of about 45,000 people. It receives a few hundred kids from grade 1 to grade 6.

Supporting Conditions for ICT Use in the Schools

Consistent with the literature on the implementation of ICT, the collective case study in this book has identified a number of influencing supporting conditions for the promising practices reported in the individual case studies (Hew & Brush, 2007; Tay, Lim, & Lim, 2010; Tay, Nair, & Lim, 2010): (1) policy and school leadership, (2) physical and technological infrastructure, (3) curriculum and assessment, and (4) professional development.

Policy and School Leadership

Policy makers and school administrators need to apply strategies to address the various barriers to successful integration of ICT in the classroom, and must support the creation of necessary and sufficient conditions for that purpose (Lim, 2007). One of the major factors in influencing ICT in the classroom is the leadership of the institution (Tay, 2011). The school leadership needs to take ownership of the project. Tondeur et al. (2008) pointed out that school-related policies, such as an ICT plan, ICT support, and ICT training, have a significant effect on the use of ICT in classrooms. National policies are also needed to address various issues, from creating a shared vision among school practitioners to building a good physical and technological infrastructure, initiating industry-school partnerships, and providing training to teachers (Lim, 2007; Vallance, 2008). Lim (2007) proposed three policy recommendations on the national level to promote ICT integration in teaching and learning: 1) develop strategies for student ICT-competency development in selected schools; 2) set ICT-competency standards for teachers and students; and 3) redesign the mode of assessment and reduce the emphasis on examination grades in order to optimize the potential of ICT for teaching and learning. Lim (2002) argues for a more holistic approach of studying ICT in schools by adopting a sociocultural perspective. He proposes that "research studies in ICT need to shift their attention towards the whole configuration of events, activities, contents, and interpersonal processes taking place in the context that ICT is used."

To execute national plans and government policies, school-based ICT plans and policies for learning and teaching with ICT are necessary (Gülbahar, 2007; Tondeur, van Braak & Valcke, 2007; Vanderlinde & van Braak, 2011). Tondeur et al. (2008) revealed five areas of school-level ICT policies that are key to the integration of ICT in the classroom: 1) ICT policy plan; 2) school leadership embodied by the principals; 3) supporting conditions such as sufficient access to ICT facilities, skilled staff, and ICT coordinators; 4) evaluation of ICT integration practices; and 5) cooperation with other schools. Lim's (2007) recommendations for school policies stressed the importance of a shared vision by all members of the school community, learning and sharing among teachers and staff, and setting up an incentive mechanism to encourage innovative practices. Throughout the process, school leadership is a key factor that impacts on ICT integration in the classroom (Tondeur et al., 2008). In their case study of ICT integration in Hong Kong schools, Yuen, Law, & Wong (2003) found that school leadership plays a crucial role in shaping the school's response to ICT innovations and the degree of ICT integration in them. School principals are especially important as they often are the ones who initiate ICT plans on both strategic and action levels (Tondeur et al., 2008).

Physical and Technological Infrastructure

The physical and technological infrastructure of ICT is a fundamental aspect of the implementation of changes to use ICT in education. Setting up the necessary infrastructure requires consideration of availability of physical infrastructure (for example, rooms for servers, computer rooms, placing of cables and network points, electricity supply points), ICT hardware and software, and human resources to set up and maintain the infrastructure and support the everyday running (Lim, Chai, & Churchill, 2010).

After ensuring sufficient ICT infrastructure for both teachers and students, schools need to employ technical assistants for maintenance work as well as to ensure that the infrastructure adheres to the software and implementation procedures (Divaharan & Lim, 2010). ICT coordinators are needed to keep schools up-to-date with new ICT developments, decide the direction of ICT use, and organise trainings for teachers. Through planning, allocating resources and budget, and giving technical and curriculum support, such coordinators guide communities of teachers in the implementation of ICT-based teaching and learning (Lai & Pratt, 2004).

Both hardware and software need to be designed following appropriate learning theories and pedagogical practices. Since different forms of ICT serve and augment different teaching and learning experiences, practitioners need to make informed judgments about which hardware and software are best for enhancing student learning in the context of their particular learning environment. Software needs to be chosen or developed after considering the instructional strategy. Classrooms which undergo the transition stage from being traditional to being ICT-facilitated may face many pedagogical problems, such as lack of appropriate visual examples, insufficient in-class practice, overloaded content, and jumbled learning sequences (Lee, 2001). Therefore, well-developed software that is motivating, well-organised, and interactive can help structure ICT-facilitated learning activities and allow students to learn individually outside of class.

Curriculum and Assessment

Governments, schools, and teachers all play a role in facilitating the development and execution of ICT integration in the curriculum. Many countries have official policies on the use of ICT to improve the quality of education. Such policies need to be implemented through concerted plans and actions at the school level, involving school leaders, administrators, and teachers. As noted by Vanderlinde and van Braak (2011), an essential condition for ICT policy implementation to be successful is good communication among educational policy officials, schools, and teachers. Consistent information to schools and teachers can link broader ICT policies to policies in the local-school level (Jones, 2003). Especially when rapid changes are brought about by ICT integration in the curriculum, encouragement and support at the school level are indispensable for teaching staff (Divaharan & Lim, 2010). One potential problem in the process of implementation is that a proposed national ICT policy and curriculum can become inconsistent with what is implemented at the school level. Tondeur et al. (2007) suggested that schools should pay attention to a few key issues to avoid this problem: a) the planning of the ICT curriculum across the schools; b) strategies to change or redirect education practices; c) access to courseware for ICT integration within the curriculum; and d) opportunities for professional development of teachers and staff. Moreover, curriculum reform related to ICT is unlikely to succeed unless teachers' personal perspectives and educational practices are understood (Niederhauser & Stoddart, 2001). There are rules, procedures, and accepted practices in the school setting. However, certain rules and conventional practices can be modified to better support the integration of ICT into the school's curriculum. For example, students may not only submit their works in conventional ways but also in digital format.

Effective use of ICT-based assessment may also play a positive role in enhancing general practices of ICT integration in the classroom. In this regard, the experiences of both teachers and students matter. A good way of implementing ICT can be based on the use of computer-based assessment tools under a specific assessment framework, agreed and practiced by teachers. The reason is that, if formal assessment is carried out via computers, teachers will need to incorporate some elements of similar tasks in their teaching to prepare students adequately (McFarlane, 2001). Moreover, when students are stimulated to think about their learning process while using the assessment tools, ICT becomes learning-oriented and it becomes possible to examine students' actions and thinking processes. Thus, ICT-based assessment tools can support student learning by directing them to useful resources, rephrasing important questions, and providing answers to their questions as well as additional information (Miller, 2009).

Professional Development

Professional development is needed for all school staff who play a role in the process of ICT integration, but the competency of teachers is most important. Littlejohn (2002) suggested several strategies for professional development to help teachers incorporate new teaching methods with the use of ICT. Such professional development programmes 1) focus on professional development outcomes that can be evaluated, 2) provide training on educational theories with reference to ICT, 3) involve academics to assist teachers in planning learning activities, and 4) offer enhanced ICT skills. Although professional development programmes are usually designed by academics, actual change starts from teachers, thus consideration of their point of view is important (Rodrigues, Marks, & Steel, 2003). Moreover, innovation in education that is not directed at actual school practices tends to fail (Fullan & Hargreaves, 1992). Professional development, therefore, needs to be local- and context-based on specific subjects in particular schools so that the professional development offered has an intrinsic value to individual teachers (Rodrigues et al., 2003).

Research studies (e.g., Loveless, 2003; O'Rourke, 2001) suggest the importance of focusing on pedagogy rather than on technology itself, and on the need to innovate teaching styles when building teachers' competences in ICT in education. There is much evidence to suggest that the process of practitioners engaging in regular and rigorous research of their own practice leads to positive and profound effects on learning and teaching (see for example, Brew, 2006; Kember, 2002; Kincheloe, 2002). One example of such innovative teaching practice is to have teachers engaged in online forums during professional development (Prestridge, 2010). This can facilitate the development of ICT teaching communities, which can foster both critical discussion and collegiality. Teachers' beliefs about ICT and education and their understanding of the value and purpose of ICT also play crucial roles in determining if and how teachers will use ICT in their classrooms (Rodrigues et al., 2003).

Moving On To the Case Studies

The account presented in this collective case study of promising practices of ICT in primary schools is a descriptive and interpretative one. It describes the school settings, explains what happens in the classrooms, and provides an interpretation of it. It deepens and amplifies the ICT in primary education work that has been carried out by IITE, and highlights the supporting conditions necessary for this promising practices. The theoretical framework has allowed us to study and document these practices with particular learning environments and broader sociocultural contexts. This collective case study will inform policymakers, school administrators, and teachers about how to take up the opportunities and address the limitations of ICT, as well as how to integrate ICT into the primary school curriculum and the broader sociocultural context. By drawing upon the similarities and differences of the sociocultural elements that support ICT use in the five primary schools studied, this document will add to the body of knowledge about the contexts and factors that contribute to the effective integration of ICT in primary schools.

References

Brew, A. (2006). Research and teaching: Beyond the divide. Palgrave Macmillan.

Cole, M. (1995). Sociocultural-historical psychology: some general remarks and a proposal for a new kind of cultural-genetic methodology. In J.V., Wertsch, P.D., Río, & A., Alvarez (Eds.), Sociocultural Studies of Mind (pp.187-214). New York: Cambridge University Press.

Divaharan, S., & Lim, C. P. (2010). Secondary school socio-cultural context influencing ICT integration: A case study approach. Australasian Journal of Educational Technology, 26(6), 741-763.

Engeström, Y. & Escalante, V. (1996). Mundane tool or object of affection? The rise and fall of the postal buddy. In B., Nardi (Ed.), Context and Consciousness: Activity Theory and Human-Computer Interaction, 325-374. Cambridge, MA: MIT Press.

Fullan, M., & Hargreaves, A. (eds.) (1992). Understanding teacher development. Teachers New York: College Press.

Gifford, B.R. (1997). Toward a new instructional architecture for distributed learning environments. Paper presented in the 1997 Annual Meeting of the American Educational Research Association. Chicago, April 1997.

Gülbahar, Y. (2007). Technology planning: A roadmap to successful technology integration in schools. Computers & Education, 49(4), 943-956.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and Development, 55(3), 223-252.

Jones, R. M. (2003). Local and national ICT policies. In R. B. Kozma (Ed.), Technology, innovation, and educational change: A global perspective (pp.163-94). Eugene: International Society for Technology in Education.

Kember, D. (2002). Long-term outcomes of educational action research projects. Educational Action Research, 10 (1), 83-104.

Kincheloe, J. (2002). Teachers as researchers: Qualitative inquiry as a path to empowerment. London: Routledge.

Korpela, M., Mursu, A., Soriyan, H.A. (2002). Information systems development as an activity. Computer Supported Cooperative Work, 11(1-2), 111-128.

Lai, K. W., & Pratt, K. (2004). Information and communication technology (ICT) in secondary schools: The role of the computer coordinator. British Journal of Educational Technology, 35(4), 461-475.

Lee, S. C. (2001). Development of instructional strategy of computer application software for group instruction. Computers and Education, 37, 1-9.

Lim, C. P. (2002). A theoretical framework for the study of ICT in schools: a proposal. British Journal of Educational Technology, 33(4), 411-421.

Lim, C. P. (2007). Effective integration of ICT in Singapore schools: Pedagogical and policy implications. Educational Technology Research and Development, 55(1), 83-116.

Lim, C. P., Chai, C. S., & Churchill, D. (2010). A capacity-building toolkit for teacher education institutions in the Asia-Pacific. Singapore: Microsoft.

Littlejohn, A. H. (2002). Improving continuing professional development in the use of ICT. Journal of Computer Assisted Learning, 18, 166-174.

Loveless, A. (2003). The interaction between primary teachers' perceptions of ICT and their pedagogy. Education and Information Technologies, 8(4), 313-326.

McFarlane, A. (2001). Perspectives on the relationships between ICT and assessment. Journal of Computer Assisted Learning, 17, 227-234.

Miller, T. (2009). Formative computer-based assessment in higher education: The effectiveness of feedback in supporting student learning. Assessment and Evaluation in Higher Education, 34(2), 181-192.

Moll, L.C., Tapia, J., & Whitmore, K.F. (1993). Living knowledge: The social distribution of cultural resources for thinking. In G., Salomon (Ed.), Distributed Cognitions: Psychological and Educational Considerations (pp.139-163). New York: Cambridge University Press.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. Teaching and Teacher Education, 17, 15-31.

O'Rourke, M. (2001). Engaging students through ICT: A multiliteracies approach. Teacher Learning Network Journal: Change, Growth, Innovation, 8(3), 12-13.

Prestridge, S. (2010). ICT professional development for teachers in online forums: Analyzing the role of discussion. Teaching and Teacher Education, 26, 252-258.

Rodrigues, S., Marks, A., & Steel, P. (2003). Developing science and ICT pedagogical content knowledge: A model of continuing professional development. Innovations in Education and Teaching International, 40(4), 386-394.

Tay, L. Y. (2011). Integrating the technological dimension into teaching and learning— a sociocultural perspective. Technology in Higher Education – The State of the Art. Centre for Development of Teaching & Learning, National University of Singapore, 80-94. Retrieved January 24, 2012 from http://www.cdtl.nus.edu.sg/tech-in-he/pdf/Section2-Article6.pdf.

Tay, L.Y., Lim, S. K., & Lim, C. P. (2010). Developing a framework for practitioner research in an ICT enriched learning environment. In L. Y. Tay, C. P. Lim, & M. S. Khine (Eds.), A school's journey into the future – Research by practitioners for practitioners (pp. 15–38). Singapore: Pearson Custom Publishing.

Tay, L. Y., Nair, S., & Lim, C. P. (2010). Supporting one-to-one computer mediated learning environments in a Singapore primary school. In L.Y. Tay, C. P. Lim, & M. S. Khine (Eds.), A school's journey into the future –Research by practitioners for practitioners (pp. 39–67). Singapore: Pearson Custom Publishing.

Tondeur, J., van Braak, J., & Valcke, M. (2007). Towards a typology of computer use in primary education. Journal of Computer Assisted Learning, 23, 197-206.

Tondeur, J., van Keer, H., & van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. Computers & Education, 51, 212-223.

Vallance, M. (2008). Beyond policy: Strategic actions to support ICT integration in Japanese schools. Australasian Journal of Educational Technology, 24(3), 275-293.

Vanderlinde, R., & van Braak, J. (2011). A new ICT curriculum for primary education in Flanders: Defining and predicting teachers' perceptions of innovation attributes. Educational Technology and Society, 14(2), 124-35.

Vygotsky, L.S. (1978). Mind in Society: The Development of Higher Psychological Processes. Cambridge (MA): Harvard University Press.

Wertsch, J. V. (1991). Voices of the mind: A sociocultural approach to mediated action. Massachusetts: Harvard University Press.

Yuen, H. K., Law, N., & Wong, K. C. (2003). ICT implementation and school leadership. Case studies of ICT integration in teaching and learning. Journal of Educational Administration, 41(2), 158-170.

Chapter 2

Beacon Primary School, Singapore

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Beacon Primary School, Singapore

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Beacon Primary School is a government school situated in a typical working class neighbourhood in the western part of Singapore. It started operations in 2008 and its first cohort of students completed their six years of primary school education in 2013. Beacon Primary is one of the eight future schools under the FutureSchools@Singapore initiative (http://edulab.moe.edu.sg/futureschools-at-singapore). The school has more than 100 teachers and 25 administrative, allied, and auxiliary staff members who support 1400 students from Primary Grade 1 to 6, aged 7 to 12.

It conducted its first Primary 1 registration exercise in July 2007 and all 240 places were taken up at the end of the registration exercise. Pupils who registered mainly came from the neighbourhood. The school was fully operational on its first school day in January 2008, starting with 240 Primary 1 pupils and 24 education officers.

The FutureSchools@Singapore programme is a collaborative project between the local Ministry of Education (MOE) and the Infocomm Development Authority (IDA). The main goal of the programme is to have a small group of schools leading the way in providing possible models for the seamless and widespread integration of ICT into the curriculum for engaged learning in schools.

The school's learning framework is consciously designed to leverage ICT to enhance the teaching and learning process. The ICT implementation includes a hybrid model of computer notebook use (2:1 or 1:1; i.e., two students to one computer and one student to one computer ratio) in a wireless environment, with interactive whiteboards in every classroom, and other relevant tools which support the attainment of the expected learning outcomes in the various school-designed programmes. The notebook computer is chosen because it allows greater mobility.

Figure 2.1 One-to-one computing learning environment for students

The school took a progressive approach by providing the necessary computing device (i.e., notebook computers). The Beacon one-to-one (B121) computing learning environment programme provides each student in Primary 1 to 3 with one school-owned computer, and subsequently requests students of Primary 4 or above to procure their own notebook computers. The conceptualisation of this two-tier, one-to-one model was developed with the notion of sustainability in mind. Students procure their own digital learning device for extension of their learning beyond the school. Financially challenged students apply for a special computer ownership scheme where more than 85% of the cost of a full-featured notebook computer and Internet broadband subscription (3 years) is subsidised by the Infocomm Development Authority. This programme and scheme also act as a social leveler for these students. Since then, a number of primary and secondary schools have also embarked on similar programmes, and the question of whether primary school students could use and own their own personal computers has never been asked again.

Figure 2.2 One-to-one computing learning environment

Use of ICT in the School

Digital Storytelling

Since 2008, several interesting and innovative teaching pedagogical practices have been developed. For example, the pedagogical approach of digital storytelling —where students create their own digital stories using text, images, sound and their recorded voices for language learning— is integrated as part of the languages curriculum. Students from Primary 1 to 3 create their own digital stories in their language classes (both in English and in their mother tongue languages, such as Chinese, Malay,and Tamil). The digital storytelling approach is the school's signature approach in the integration of ICT into the learning of languages.

Figure 2.3 Figure 2.3. Students using tablet PC for Digital Storytelling

Storytelling is one of the oldest art forms that is inextricably intertwined with learning. Both children and adults learn more effectively through storytelling than in any other way (Tomlinson, 2003). Stories have been found to engage learners and facilitate learning through unconscious processes (Morgan & Rinvolucri, 1983). By telling a story, learners reflect on what they know, examine their views, and record their own personal experiences. Since storytelling enables learners to express themselves and make sense of the external world (Heo, 2004), it may be used to assess learning goals. In fact, with digital tools, it is even easier to share, revise, and critique stories and learn from one another. Several researchers have studied using technology (such as word processor) to write a story and employing communication tools to share it among learners (Fusai, Saudelli, Marti, Decortis, & Rizzo, 2003). This practice of using personal digital technology and combining different media (Ohler, 2008) to tell a personal story is commonly known as digital storytelling. Hull and Nelson (2005) define digital storytelling as a form of multimedia that comprises images and segments of video with background music and a voice-over narrative.

Figure 2.4 Figure 2.4. Students using notebook computers during their lessons

Digital storytelling is simply the application of technology to the "ancient" experience of sharing personal narratives (Armstrong, 2003). However, the dynamic nature of digital storytelling lies in the fact that learners undergo several cognitive processes that underpin learning a variety of skills, from verbal linguistic skills to spatial, musical, interpersonal, intrapersonal, naturalist, and bodily-kinaesthetic skills (Lynch & Fleming, 2007). To produce a digital story, a learner needs to write a script, include suitable photographs or clipart, insert music that appeals to the story, and add recorded voices that narrate the experiences to a target audience. By creating personal narratives, learners become active creators of multimedia (Ohler, 2008) because the "new media narrative" allows for self-expression in ways not traditionally supported by most school curriculum (Banaszewski, 2005). Furthermore, according to Levin (2003), the new technology that students currently have access to provides them with opportunities to communicate in ways that were not possible ten years ago. With technology, learners working on digital storytelling can articulate their views creatively in the form of images, video, or sound, and can share their stories with the rest of the world.

Figure 2.5 Students creating their digital stories

Figure 2.6 Students adding their personal voices into their digital stories

Flipped Classroom

Mathematics teachers experimented with the flipped classroom concept to engage and enhance students' academic performance. Students learned content on solving sum problems by watching teacher-created online videos before they came to class. The students then focused on practicing sums in class with guidance from the teachers. Both students and teachers welcomed this approach and they reported feeling that it can help their learning and academic performance, especially for mathematics.

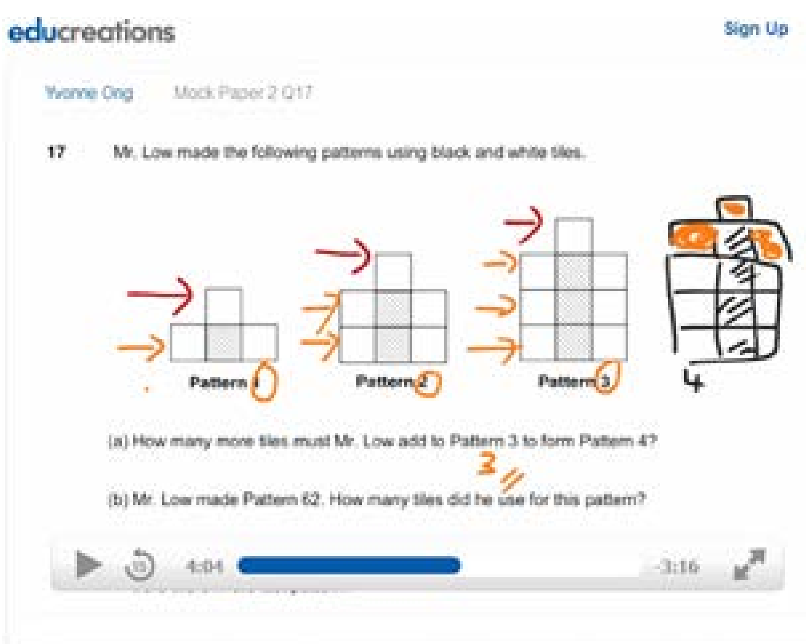

Figure 2.7 Screen capture of teacher-created video on a mathematical summation problem

The flipped classroom is a form of blended learning in which students learn online at least part of the time while attending the conventional school (Horn, 2013). Horn (2013) succinctly explains that in the flipped classroom students view lessons and lectures online before class, and their later time in the classroom, previously reserved for teacher instruction, is spent on what we used to call homework, with teacher assistance as needed. This model is also known as "The Inverted Classroom" (Lage, Platt, & Treglia, 2000), where teaching and lessons take place outside of class, and class time is devoted to group and individual problem solving, discussion, and experiments. The rationale for such an approach, similar to the flipped classroom, is to allow students to spend time working through their sums or questions on their own, with teachers later assisting those who need more help (Lage & Platt, 2000). The content is taught through digital means, through the use of teacher-created videos or other media, prior to face-to-face class time. The Internet allows for the flipped or inverted classroom to deliver the necessary content.

Use of Blogs and Open-source Software Applications

With the proliferation of the Internet and broadband networks over the past decade, the use of online software applications is becoming more popular and prevalent in schools (Tay, Lim, Lye, Ng, & Lim, 2011) and many of such software applications are easily available at relatively low or no cost. Even in schools where technical expertise is not available, the commercially available learning management systems often have functions and features of online software applications as mentioned above (Anderson, 2006). Since the middle of the last decade, several authors have already called for the inclusion and integration of the commonly used online social software applications into the commercially available learning management systems (Craig, 2007; Dalsgaard, 2006; Mott, 2010; Sigala 2007; Kemp & Livingstone, 2006). Beacon Primary School uses such online software applications quite extensively for all students for the various subjects taught (English, Mathematics, and Science).

All teachers used blogs in their lessons, not only for information dissemination and online collaboration, but also as an online platform that linked to other online software applications (e.g., links to online videos, games, etc.). In other words, the blog site became the gateway to other applications. The blogs were also used as a platform for students to hold online asynchronous discussions. The interview with the teachers has provided a detailed descriptive account of how blogs and the various types of online software applications were used by the teachers. Blogs seem to be the gateways to other online software applications.

In terms of other applications, online games were used to reinforce skills and concepts learned. Learning management systems were mainly used for learning of subject-related content via digital animated applets and online quizzes. Students and teachers used search engines to look for supplementary information for teaching and learning. And online digital videos were used mainly to elaborate on and reinforce concepts and contents taught and learned.

Supporting Conditions for ICT Use in the School

The introduction of innovations and new technologies into any learning situation requires careful planning and a good deal of developmental testing. This process often requires multidisciplinary approaches involving teachers, researchers, technologists, developers, and students (Hartley, 2007). Amongst them, teachers are pivotal in creating ICT-mediated learning environments (Lim, 2007). In this section we will focus on presenting the necessary and sufficient conditions to adequately support ICT for teaching and learning in schools.

Policy and School Leadership

Policy and school leadership play an important role in the integration of ICT in the classroom (Lim, 2007; Tay, 2011). Both school policies (Tondeur, van Keer, van Braak, & Valcke, 2008) and national policies (Lim, 2007; Vallance, 2008) are needed to ensure the effective implementation of ICT in classrooms. Some vital issuesare the buildings and infrastructure, a shared vision among practitioners, and the provision of professional development for teachers. School leaders can initiate ICT plans and help to address any obstacles encountered in the process of ICT integration by their staff (Tondeur et al., 2008).

Curriculum and Assessment

ICT integration requires modifications in the curriculum and assessment methods. It is important for the implementation at the school level to be consistent with the national ICT policy and curriculum (Tondeur, van Braak, & Valcke, 2007). A direct implication of this is that curriculum reform should take into consideration teachers' personal perspectives, teaching practices, and support (Divaharan & Lim, 2010; Niederhauser & Stoddart, 2001).

The school implements both conventional and alternative assessments to assess students' different skills, competencies, and learning outcomes, and students are given progress cards each term to update parents of their progress. The alternative assessments include the evaluation of students' drama performance, audio recordings, digital stories, journals, and portfolios. Technology enabled teachers to use alternative assessment forms. For example, the audio recordings by pupils, in preparation for oral examinations, enabled teachers to better facilitate students' practice. Other forms of assessment implemented in the school involved various stakeholders in the learning process. Students are also actively engaged in reflections as they develop their initial personal portfolios. The wide range of assessments has allowed the school to report on the pupils' development beyond academic results and inform students, parents, and teachers on specific aspects of the students' development in a broad range of areas. The school continues to look at assessment to determine ways to further provide meaningful ways to inform pupils of their learning and development.

Professional Development

Professional development has been found to be a significant factor for ICT implementation in the literature (Littlejohn, 2002; Prestridge, 2010). Therefore, the school places due emphasis on staff development and focuses on helping teachers gain sufficient competencies in the areas of curriculum design and integration, pedagogical approaches, assessment practices, technology integration, and educational research. Teachers are provided with professional development opportunities through online platforms, workshops and conferences, internal and external sharing sessions and discussions, and spanning subjects and levels. This will enable teachers to be both pedagogically and technically competent to contribute to and facilitate teaching and learning with ICT.

In addition, the school has launched an initiative of practitioner research, where teachers become researchers to systematically reflect, learn, improve, and share their practices. For instance, interviewed teachers reflected that their research benefitted other teachers, and expressed that an important part of engaging in the research process was to be able to later disseminate the findings. Since 2008, several interesting and innovative pedagogical practices have been developed. The school uses practitioner research as a way to enhance teachers' competencies and continue professional development. For example, the digital storytelling pedagogical approach for languages and the flipped classroom concept for mathematics and science were piloted and implemented in the school. But along with being implemented, they were also recorded systematically and shared via conference presentations, book chapters, and journal articles with the fraternity. The value and impact of this deliberate documentation are that the rationale, intent, and perspective of the practices can be captured for sharing with others who, in turn, can further contemplate on the approach.

Physical and Technological Infrastructure

A wide range of technological tools were used to integrate ICT into teaching and learning. In terms of hardware, the school started implementing its one-to-one computing efforts from 2008, when it opened its door to its first cohort of Primary 1 students. Each classroom was equipped with an interactive whiteboard and two LCD projectors. During the initial months in 2008, the laptop computers were stored and charged in wooden mobile units. Each unit could only house six laptops. The mobile storage and charging units were initially shared among the eight Primary 1 classes. A wireless internet environment was also set up in the classrooms to further support the one-to-one effort. As initial usage numbers of the laptops was encouraging, the school subsequently equipped all Primary 2 and 3 classes with computers at a one-to-one ratio, and the Primary 1 classes at a two-to-one ratio. Efforts were also made to redesign earlier versions of the mobile storage unit. A more functional mobile storage unit, still with charging capability but with a bigger storage capacity —able to house 20 laptop computers per unit— was co-developed with the industry partner.

Figure 2.8 Mobile storage cart for storage and charging of the notebook computers in the classrooms

The school has equipped key learning facilities such as classrooms with Interactive White Boards (IWB), dual projectors, personal learning devices, and wireless connectivity. The classrooms were furnished to allow flexible use of space, enhance mobility of teachers, and encourage various types of interactions. Seating has been arranged in groups, acknowledging the importance of collaborative learning. In addition to building of an appropriate physical infrastructure, the school has successfully adopted the use of open-source software infrastructure to provide essential teaching and learning facilities to teachers and students. The computer ownership programme for all Primary 4 students was in its successful 4th iteration in 2014. These infrastructures formed the ballast for ICT learning, enabling the school to leverage on technologies effectively.

Figure 2.9 Figure 2.9. Students in the studio for their lesson

Figure 2.10 Figure 2.10. Student and teacher using the Interactive Whiteboard

Partnership and Engagement

Partnership with and engagement of significant and relevant stakeholders are also essential for the use of ICT for teaching and learning in schools. No man is an island; similarly, no school is an island. The FutureSchools@Singapore programme is a joint project between the Ministry of Education (MOE) and the Infocomm Development Authority (IDA). Officers from both agencies have worked with the school since December 2006, during the planning phase of making the school a Future School. The school community consists of the parents, school administrators, teachers, non-academic staff, MOE, IDA, Institutes of Higher Learning (IHL), and industry partners. Partnership with the local MOE, IDA, and industries is undoubtedly an important factor that assists in the efforts to use ICT for teaching and learning, and the local IDA and MOE authorities provide the necessary budget or infrastructure for the data network for the schools. Engaging parents and getting their support in the use and purchase of computing equipment for children also greatly facilitates the use of ICT in the classroom. Expectations from the community about turning the school into a Future School that leverages on ICT for teaching and learning has been very clear. IHL supports the school in terms of educational research efforts, while industry partners support the school through the development of its online applications for teaching and learning. Integration of ICT, consequently, goes beyond what happens within the classrooms. The school and the society also have a clear impact on the practices that get established in the classrooms.

National Education Policy and Initiatives

Singapore's ICT Masterplans provide a direction for the use of ICT in education. The basic philosophy of the Masterplans is that the educational system should prepare our students to meet the needs of the future. The first ICT Masterplan in education (1997 to 2002) laid the foundation for schools to harness and use ICT. Under this phase, schools were equipped with the basic ICT infrastructure and teachers with a basic level of ICT integration skills. The second Masterplan (2003 to 2008) further strengthened the integration of ICT into teaching and learning, established baseline ICT standards for students and promoted the innovative use of ICT among schools. The third ICT Masterplan in Education (2009 to 2014) was launched in August 2008 by the Ministry of Education and it was a continuation of the earlier two masterplans, with the goal of transforming pedagogy and providing students with the ICT competencies necessary for the future.

The third and current ICT Masterplan in Education has the following objectives: (1) to strengthen integration of ICT into curriculum, pedagogy, and assessment in order to enhance learning and develop competencies for the 21st century; (2) to provide differentiated professional development that is more practice-based and models how ICT can be effectively used to help students learn better; (3) to improve the sharing of best practices and successful innovations; and (4) to enhance ICT provisions in schools to support the implementation of Masterplan 3.

This third Masterplan looks more specifically into the alignment of students' learning outcomes in the curriculum, national examinations, and classroom experience with 21st century skills that will enable them to collaborate and communicate effectively. It also considers efforts to train a pool of ICT specialist teachers with strong pedagogical groundings to model and share practices within and across schools. It establishes continued support for innovative ICT teaching practices in schools (e.g., LEAD ICT@Schools and FutureSchools@Singapore programs), and resolves that those innovative and effective practices must continue to be shared and be cascaded to other schools. It also provides for greater infrastructure provisions such as wireless internet access, establishing the 1-to-1 notebook-to-pupil ratio in more schools, and higher Internet data bandwidth.

At the same time, the IDA in Singapore has developed a 10-year masterplan to grow the information and communication sector and to use ICT to enhance the competitiveness of key economic sectors and build a well-connected society (http://www.ida.gov.sg/Infocomm-Landscape/iN2015-Masterplan). The iN2015 (Intelligent Nation 2015) blueprint was developed with the specific goals of using ICT to add value to the economy and society, generating revenues and creating jobs with wide-spread use of broadband networks, and achieving 100% computer ownership for all school students.

Challenges and Way Forward

Starting a project is not easy; sustaining it is even more challenging. The transition from funded project to sustainable educational innovation in the area of ICT could be a problematic endeavour (Gunn & Uys, 2011). Starting such a project requires not only great effort, but also insights and tenacity to subsequently sustain it in the long run. And sustainability here does not only refer to technological infrastructures and equipment. It also refers to the sustainability of innovative teaching practices and the sustainability of school leadership. Sustaining innovative teaching practices requires not only coming up with new ideas but also cascading these ideas beyond the classroom and beyond the school. For instance, the school's mobile storage carts for notebook computers and open-source online learning infrastructure were shared with the fraternity via various means (i.e., MOE Excel Fest, eduLab, seminars and conferences). Sustainability also refers to constant and effective teacher professional development, so that teachers may be in a better position to assimilate new practices. In addition, sustaining school leadership does not only refer to a consistent person or set of persons that make up a management team, but also to how the school leadership makes the implicit knowledge more explicit in order to facilitate the continuity and consistency of the school's vision and philosophy. In every aspect of education, it is valuable to explicitly record the learning points and insights gained, so that these experiences and knowledge can be easily shared within the school and beyond.

The commitment and perseverance of all involved, as well as a strong leadership and a high level of technical and pedagogical knowledge and skills (Khalid, Nawawi, & Roslan, 2009; Tay, 2011) can facilitate the implementation and sustainment of the above education technology innovations. In other words, committed and capable individuals remain the single most important success factor for sustainable innovations (Gunn & Uys, 2011).

In essence, the implementation and effective use of ICT still require committed and capable teachers to bring out the potentials of such systems, be it technical or pedagogical competencies. In our opinion, innovations in education should also deserve consistency of school leadership, administration, and teachers for a substantial period of time for a better chance of sustainability and survivability. The consistency of a staff that is involved and has good in-depth knowledge and skills in such a project would greatly enhance the survivability of many of the educational innovations in today's very fluid and fast-changing environment.

References

Anderson, T. (2006). Social software applications in formal online education. In Kinshuk, R. Koper, P. Kommers, P. Kirschner, D. G. Sampson, & W. Didderen (Eds.). Proceedings of 6th IEEE International Conference on Advanced Learning Technologies (pp. 909-911). 5–7 July 2006, Kerkrade, The Netherlands: IEEE Computer Society.

Armstrong, S. (2003). The power of storytelling in education. In Armstrong, S. (Ed.), Snapshots! Educational insights from the Thornburg Center (pp.11–20). The Thornburg Center: Lake Barrington, Illinois.

Banaszewski,T. M. (2005).Digital Storytelling: Supporting Digital Literacy In Grade 4–12. Master's thesis, Georgia Institute of Technology. Retrieved February 22, 2009 from http://techszewski.blogs.com/techszewski/files/TBanaszewski_DS_thesis.pdf

Craig, E. M. (2007). Changing paradigms: managed learning environments and Web 2.0. Campus-Wide Information Systems, 24(3), 152-161.

Dalsgaard, C. (2006). Social software: E-learning beyond learning management systems. European Journal of Open, Distance and E-Learning.

Divaharan, S., & Lim, C. P. (2010). Secondary school socio-cultural context influencing ICT integration: A case study approach. Australasian Journal of Educational Technology, 26(6), 741-763.

Fusai, C., Saudelli, B., Marti, P., Decortis, F., & Rizzo, A. (2003). Media composition and narrative performance at school. Journal of Computer Assisted Learning, 19, 177–185.

Gunn, C., & Uys, P. (2011). From funded project to sustainable product: elearning innovations in transition. In G. Williams, P. Statham, N. Brown, & B. Cleland (Eds.), Changing Demands, Changing Directions. Proceedings ascilite Hobart 2011, 520-521. http://www.ascilite.org.au/conferences/hobart11/procs/Gunn-symposium.pdf

Hartley, J. (2007). Teaching, learning and new technology: A review for teachers. British Journal of Educational Technology, 38(1), 42-62.

Heo, H. (2004). Storytelling and retelling as narrative inquiry in cyber learning environments. In R. Atkinson, C. McBeath, D. Jonas-Dwyer & R. Phillips (Eds). Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference (pp.374–378). Perth, 5–8 December. http://www.ascilite.org.au/conferences/perth04/procs/heo.html

Horn, M. B. (2013). The transformational potential of flipped classrooms. Education Next, 13(3). Retrieved from http://educationnext.org/the-transformational-potential-of-flipped-classrooms/

Hull, G., & Nelson, M. (2005). Locating the semiotic power of multimodality. Written Communication, 22, 224–61.

Infocomm Development Authority, Singapore. iN2015 Masterplan. Retrieved November 3, 2013 from http://www.ida.gov.sg/Infocomm-Landscape/iN2015-Masterplan.

Kemp, J., & Livingstone, D. (2006). Putting a second life "metaverse" skin on learning management systems. Proceedings of the Second Life Education Workshop at the Second Life Community Convention, San Francisco – 20 August 2006.

Khalid, F., Nawawi, M. H., & Roslan, S. (2009). Integration of ICT in Malaysian secondary schools: what conditions will facilitate its use? The International Journal of Learning, 15(12), 85-93.

Lage, M. J., & Platt, G. (2000). The internet and the inverted classroom. The Journal of Economic Education, 31(1), 11-11.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. Journal of Economic Education, 31(1), 30-43.

Levin, H. (2003). Making history come alive. Learning and Leading with Technology, 31(3), 22–27.

Lim, C. P. (2007). Effective integration of ICT in Singapore schools: Pedagogical and policy implications. Educational Technology Research and Development, 55(1), 83-116.

Littlejohn, A. H. (2002). Improving continuing professional development in the use of ICT. Journal of Computer Assisted Learning, 18, 166-174.

Lynch, G., & Fleming, D. (2007) Innovation through design: A constructivist approach to learning. LAB 3000, RMIT University. Retrieved June 2, 2009 from http://lab.3000.com.au/research/research/index.jsp.

Ministry of Education, Singapore (2008). Press Release – MOE Launches Third Masterplan for ICT in Education. Retrieved from http://www.moe.gov.sg/media/press/2008/08/moe-launches-third-masterplan.php

Morgan, M., & Rinvolucri, M. (1983). Once upon a time: Using stories in the language classroom. New York: Cambridge University Press.

Mott, J. (2010). Envisioning the post-LMS era: the Open Learning Network. Educause Quarterly, 33(1), 1-9.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. Teaching and Teacher Education, 17, 15-31.

Ohler, J. (2008). Digital Storytelling in the Classroom. New Media Pathways to literacy, learning and creativity. United States of America: Corwin Press.

Prestridge, S. (2010). ICT professional development for teachers in online forums: Analyzing the role of discussion. Teaching and Teacher Education, 26, 252-258.

Sigala, M. (2007). Integrating Web 2.0 in e-learning environments: a socio-technical approach. International Journal of Knowledge and Learning, 3(6), 628-648.

Tay, L. Y. (2011). Integrating the technological dimension into teaching and learning— a sociocultural perspective. Technology in Higher Education – The State of the Art. Centre for Development of Teaching & Learning, National University of Singapore, 80-94. Retrieved January 24, 2012 from http://www.cdtl.nus.edu.sg/tech-in-he/pdf/Section2-Article6.pdf

Tay, L. Y., Lim, C. P., Lye, S. Y., Ng, K. J., & Lim, S. K. (2011). Open-source learning management system and Web 2.0 online social software applications as learning platforms for an elementary school in Singapore. Learning, Media and Technology, 36(4), 349 – 365.

Tomlinson, B. (2003). 'Humanizing the coursebook.' In B. Tomlinson (Ed.), Developing materials for language teaching (pp. 162–173). London: Continuum.

Tondeur, J., van Braak, J., & Valcke, M. (2007). Towards a typology of computer use in primary education. Journal of Computer Assisted Learning, 23, 197-206.

Tondeur, J., van Keer, H., van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. Computers & Education, 51, 212-223.

Vallance, M. (2008). Beyond policy: Strategic actions to support ICT integration in Japanese schools. Australasian Journal of Educational Technology, 24(3), 275-293.

Chapter 3 State-financed Educational Institution Educational Centre "Educational Technologies", Moscow Russia

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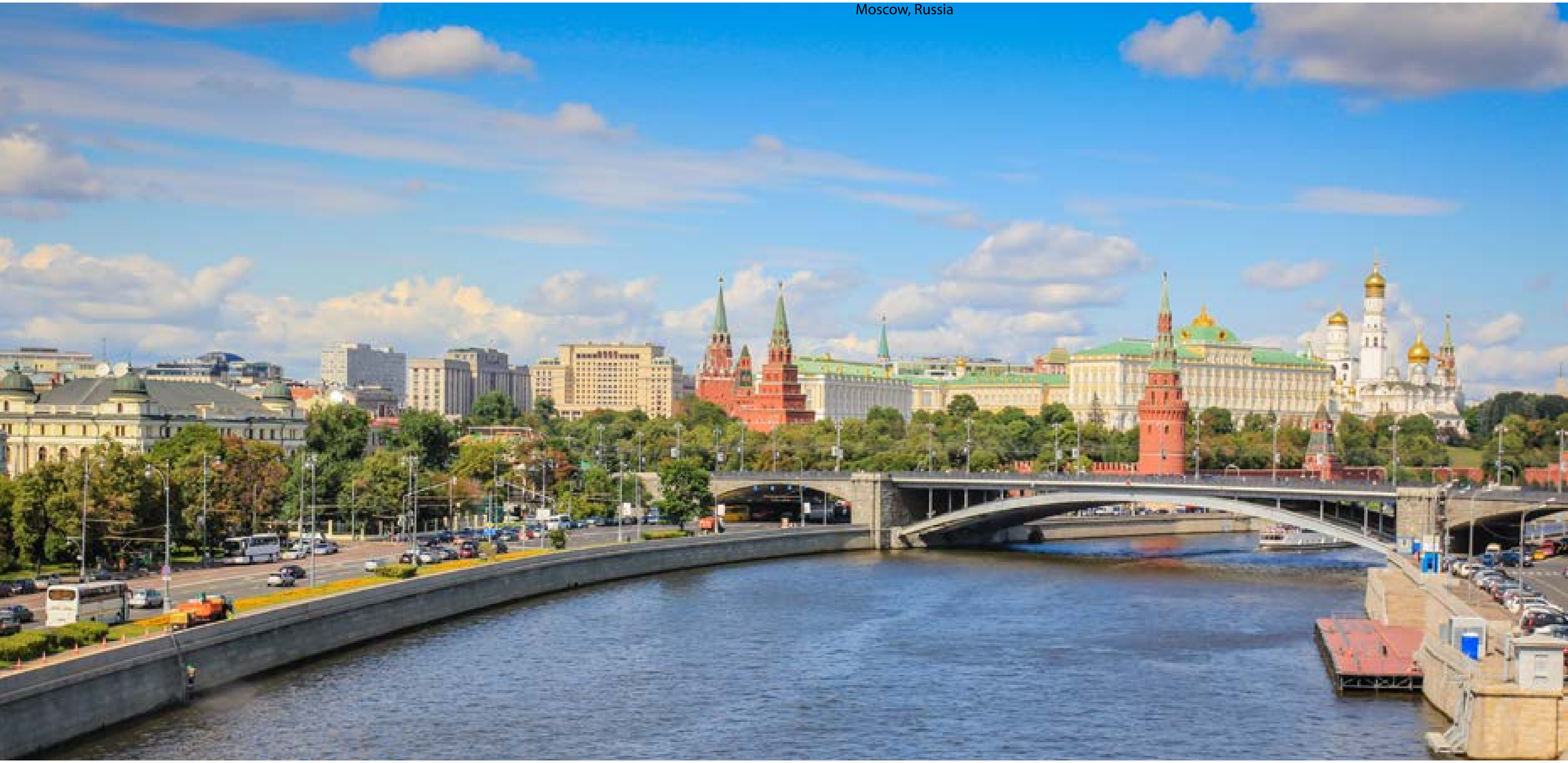

Located in Moscow, Russia, the State-financed Educational Institution (SFEI) Educational Centre (EC) "Educational Technologies" was established in 2003 as a structural subdivision of the Centre for Information Technologies and Training Equipment. The main purpose of the subdivision is to provide continuous access to quality education and active social inclusion for children with disabilities using ICT and distance-learning technologies. SFEI EC "Educational Technologies" was registered as an independent educational institution on October 26, 2005. It provides primary, basic, and upper secondary education, as well as a broad range of additional educational services.

The EC's website (www.home-edu.ru) contains ICT support and maintenance of lessons for all subject areas and all years of study. It contains separate courses for different subjects, including theory and practice tasks of different types —including academic, creative, research-based, and project-based tasks—, allowing every student to be actively engaged in learning. In addition to the availability of ICT-support for school subjects, students can complete all learning tasks with the use of ICT tools. Almost every learning task is published on the school website and many of them have become class assignments for students.

Infrastructure

The school is located in a four-storey building built in the 1950s. Its facilities cater to the special needs of the Educational Centre students, and include ramps, elevators, stairlifts, specially-equipped toilets, and sensory rooms. Students can either come to the school or study at home through the use of distance-learning technologies. The platform Moodle is employed as the learning management system for distance learning in the school.

The full-time section of the school teaches about 400 lessons daily. Since each classroom, with an area of about 40 square meters, is large enough for seven to eight lessons to be held simultaneously, it is divided into sections with noise-proof dividing fences 1.5 m or 2 m tall. There are a total of 53 mini-classrooms in the school. Each room is equipped with a certain number of computers, depending on the number of students and teachers in class. The rooms also contain peripheral equipment, such as printers, scanners, web-cameras, speakers, interactive whiteboards, and subject and didactic equipment, as well as special computer mice, keyboards, and joysticks adapted for children with serious injuries of the locomotor system. To provide the opportunity for conducting and following remote lessons, each student and teacher has a work area equipped with a computer, printer, scanner, webcam, graphical touch pen, headphones, and Internet connection. In some cases, the working area can be also equipped with digital cameras, sensing devices , robotechnic kits and tools , musical keyboards, etc. For adjustment of the working area on demand, there are assistive mice, keyboards, and Brail printers.

Figure 3.1 Work place with computer and peripheral equipment

Student Profile

Students of SFEI EC "Educational Technologies" who receive core education and additional education services are pupils of primary school with hearing or visual injuries, serious injuries of the locomotor system, effects of ICP, somatic diseases, severe chronic illnesses, effects of cerebrocranial injuries, post-traumatic stress disorder, eyesight and speech disorders, oncological diseases leading to the preservation of intellectual activity, and children with disabilities.

Organizational Structure of School and Teacher Profile

There are 256 teachers at the school, 250 of whom have received higher professional education. Some of the teachers have degrees, government awards, prizes, or have won diplomas and a variety of professional contests. Different teachers teach different subjects and children mainly learn in small groups. For professional development, all teachers engage in continuing education, which is a prerequisite for working in this Educational Centre, and may include taking courses, attending seminars, among others.

In addition to full-time teachers, there are about 100 part-time teachers mainly working with students receiving additional education services.

ICT Use in Primary Education

At the primary school of SFEI EC "Educational Technologies", almost all types of ICT tools, including hardware and software, are widely and actively used.

Each student and teacher of the primary school has unlimited access to hardware tools such as computer, printer, devices for entering textual information and operations with screen objects (mouse, keyboard, and similar devices), devices for recording visual and audio information (scanner, photo camera, and video camera), data loggers (digital sensors and meters), computer-controlled devices (programmable models), and public access to the intranet and to the global information network through the Internet.

Each student and teacher at the school has access to the following software tools, which are placed on the school's website:

1. Information management systems: an online grade book and online record journal, which are integrated with the education website and provide different users (teachers, students, administrators) with different levels of access.
2. Virtual construction kits, which give opportunities for the students to design visual and symbolic models of mathematical reality and to conduct experiments with them.
3. Training tasks that allow students to practice working with data objects —entering text and operations with graphic objects on the screen— as well as communication in writing and orally in a verbal environment.
4. Test environment.
5. Creative environment for project execution: PervoLogo, iStopMotion, iMovie, GarageBand, Google services (maps, docs).
6. Communication environment: Webinar.ru, Google+, iChat, Skype.
7. Applications that provide remote educational cooperation: TeamViewer, RemoteDesktop.
8. Informational environment: the school's website serves as an interactive educational and communication environment. Its contents and interactive opportunities are used by teachers both to prepare for and to conduct lessons on a daily basis. The website provides not only course contents, but a space for discussions and for solving work issues. It is also used to publish project activities, which are widely conducted at the school.
9. With the transformation of the teaching practice from having a simply reproductive role to an actively productive one, educational activities in the school are organized as a number of projects. And since students of SFEI EC "Educational Technologies" often conduct their studies remotely, and since many of them have special and restricted mobility, the majority of the projects are digital in nature, implying that they should be done in an informational environment with software applications.

Some examples of ICT use in SFEI EC "Educational Technologies" follow.

Example 1. Integrated Study Project "Teremok"

The project is catered for the third grade students and it covers subject areas of literary reading, computer science, Russian language, drawing, and handicraft. The project objective is to create a cartoon based on the fairy tale "Teremok". The project involves the following tasks that need to be solved by the students, which cover a wide range of subject areas. First of all, they explore peculiarities of cumulative folk tales about "Teremok" based on alternatives of the tales (literary reading). Second, they create their own imitations of cumulative folk tales and prepare for publication on the website so that they can be further worked with in the future (literary reading, and Russian language). Third, they split the text into episodes, which will become the scenes of the cartoon (literary reading). Fourth, they make the voice-overs for the cartoon (literary reading). Fifth, they design the decorations of the cartoon corresponding to the subject plan of the fairy tale (drawing). Sixth, they create the cartoon characters (handicraft). Seventh, they create a series of photos in the software of iStopMotion and add a soundtrack (informational technologies).

The first step of the project is to conduct a series of lessons on literary reading based on the website contents related to the research on peculiarities of folk tales.

Figure 3.2 Screen capture of the research on peculiarities of folk tales

The second step is to develop their own text imitations of folk tales. The work is conducted in small groups, and the collaborative works are gathered using a google e-document. Students can work at the school or remotely at home. Through video conferencing and as far as they have the editorial access to the e-document, students can discuss, write collectively, edit the text, split it into episodes according to the learning tasks, etc. The learning forum helps the members of the study group to articulate their opinions, gives them observations, and provides them with recommendations for the improvement of the text.

Figure 3.3 The learning forum

In the third step, students have to cast the roles. If there are students who only work remotely and have no opportunity to come to school take on the responsibilities of preparing the text for publication, they split the text into episodes, find images of the characters on the Internet, and make voice-overs for the cartoon. Students who physically attend school have to prepare the backdrops and characters. It is vitally important that children learn to understand the disabilities of their partners and adapt to their limitations. Sometimes they may not be able to finish the task they want to engage in and have to pass it on to someone else.

Figure 3.4 A group of students working together

In the fourth and final step, the children simulate the motions of the characters set on film in front of the backdrop. Each motion is shot with iStopMotion, a soundtrack is added, and then the cartoon is ready. This project requires the constant support from the subject teachers, which is made possible throughout the whole project via the forum on the school website.

Students conduct many literary projects using these technologies and procedures. The tool of cartoon animation addresses a number of different tasks, including the subject tasks of visualizing the reading text, splitting the text into episodes, defining the characters, defining the subject plan, reading by role playing, understanding that literary works are man-made and conditional, as well as the meta-subject tasks of planning, finishing the work that has been started, understanding and assimilating the need of improving something that has been created, developing the ability to relate outcomes and intentions, and finally communication skills, since the whole project cannot be finished individually.

Example 2. Organization of Extracurricular Activity "All-Russian Network Reading Contest"

The project is catered for students from grade one to grade four, covering the content of poetry, which is beyond the purposeful reading in the lessons of literary reading. Every year, the SFEI EC "Educational Technologies" becomes the stage of a reading contest for students of distance-learning centres from all regions of Russia. The theme of contest is different every year, but the structure is the same, with emphasis on guiding principles of a multistage approach, variability, and accessibility.

The 2013 contest was named "The world seems to be all to all" and was committed to the theme of comparisons and metaphors.

On the first stage, the statute and structure of the contest were decided on and published on the website. Invitations, an informational letter, and the statute of the contest were published on the news forum, to which participants from previous years were already subscribed. The schedule of contest activities could also be found on the website.

After the participants had confirmed their participation in the contest, its beginning of was announced. The first task was to find and select a poem that contained comparisons and/or metaphors. The poems were published on the forum, which was accessible by any participant. This way, the students' tasks at this stage were not just searching, selecting the correct poems, or discovering comparisons and metaphors as literary devices, but also acquainting themselves with the poems chosen by the other participants.

On the second stage of the contest, the project work started. Participants created video clips of themselves reading the selected poems and published those videos on the forum. At the same time, films with photos or cartoons were created to illustrate the concepts of comparisons and metaphors and were also published on the forum.

The third stage was the semi-final voting. Each participant could vote for three video clips of their fellow students reading poems using specially prepared forms. At the same time, there was a voting for the best film or cartoon, but it was elected among the adult jury, which was open for any teacher to become a member of.

On the fourth stage, the top five participants in each age group who received most of the votes would appear with their reading in the open contest, which could be attended either in person or remotely via video broadcasting for all distance-learning participants.

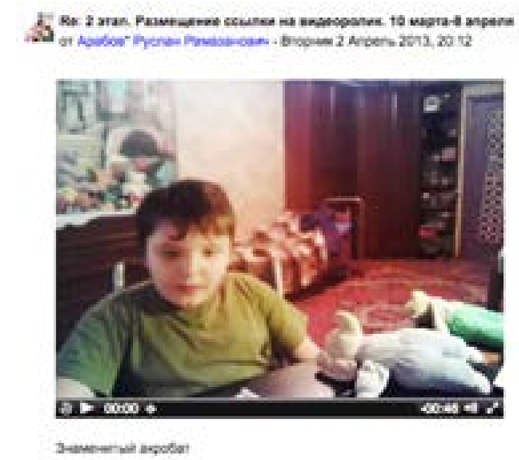

Figure 3.5 A video clip published

After all participants of one age group had presented their poems, the voting began, with special voting papers for participants at school and internet voting forms for distant participants.

The contest ended with the publications of the contest results, a final report about the contest, and photos for downloading.

Example 3. Learning Integrated Project "The Adventures of Paddington Bear and His Friends from iSchool in Moscow"

The project is catered for the third- and fourth-grade students, and it covers the subject areas of Moscow studies, English language, Russian language, and information technologies. The project has the following objectives: 1) to get acquainted with the social and cultural realities of the country of the studied language; 2) to get acquainted with contemporary English literature for children of a given age and to read the original text; 3) to develop linguistic and cultural competencies; 4) to involve all of the students in project activities in accordance with their individual capabilities; 5) to compare the traditions and realities in English-speaking countries to those of the students and to develop a sense of independence in revealing the clues or attributes for the comparison.

The project has the following stages: 1) reading and translation of the original book in class; 2) watching the cartoon in English language; 3) a teaser (brainstorming) that includes greetings to the bear, deciding who comes to Moscow, and inviting the children in English language; 4) students creating their own stories and discussing the cultural realities of Moscow in the lessons of Moscow studies; 5) preparations for cartoon filming, including image design, plot outline, and phrase recording in English language; 6) filming of the cartoon; 7) writing travel notes of Paddington Bear as a result of the knowledge integration of Moscow Studies; and 8) layout and printing of the book.

The learning outcomes are divided into groups according to the Federal State Education Standards. Subject-related outcomes include: 1) the removal of barriers to work with unadapted text; 2) growth of vocabulary; 3) practicing speeches and new grammatical structures; 4) developing skills to conduct a dialog in the studied language; and 5) gaining updated linguistic and cultural knowledge. Meta-subject outcomes include: 1) organized group work using Google documents; 2) teamwork skills and the creation of a collaborative atmosphere with mutual help among students; and 3) the involvement of their own life experience as a basis for the story creation. Pedagogical and student-centred outcomes include: 1) the acceptance of students' basic international values and the possibility to conduct intercultural dialog; 2) the formation of impulses for self-development, self-reflection, self-checking and self-assessment; 3) the development of kindness and emotional intelligence, as well as the understanding of and empathy toward other people; and 4) the formation of tolerance and a culture of international communication, as well as a respect for the language, cultural traditions, history, and the way of life of the country of the studied language. The final products include a book in both digital and paper formats, and also a cartoon.

Figure 3.6 A book chapter created by the students

Example 4. Engaging Children in School Life through Connections to Video Broadcast of School Events

The school has a tradition to hold a project festival annually. The 2013 festival held in the primary school revealed that pupils were able to choose a topic to illustrate their understanding and knowledge of the field they were interested in, and that they could choose the appropriate ICT tools to solve the tasks easily.

Figure 3.7 A student participating in the project festival remotely

The following examples illustrate the choices of ICT-tools made by students:

1. Video report with voice-over
2. Animated cartoon with voice-over
3. Multipage album in PervoLogo

Figure 3.8 Multipage album

4. Online presentation in google doc
5. E-book with a video presentation of the project

The above overview of the use of ICT tools demonstrates that ICT is widely used in the school activities and that students realize the possibilities of the ICT tools they have at their disposal and that they have the skills necessary to use them to express their ambitions.

Chapter 4 American

Institute of Monterrey, Mexico

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The American Institute of Monterrey (AIM) was founded in 1968 in the city of Monterrey, Mexico, as a private bilingual (English-Spanish) educational institution serving a primarily Mexican student population. AIM is housed on two different campuses, with the San Pedro Campus serving students from preschool to third grade, and the Santa Catarina Campus serving students from fourth to ninth grade. In the school year of 2012–2013, a total of more than 1200 students, aging from 3 to 16, enrolled in 13 grade levels from preschool to ninth grade (http://www.aim-net.mx/newsite/aim2011/index.php).

In 2006 the AIM unveiled to its school community a major overhaul of its educational system in order to respond to the needs of the 21st century learners: They would introduce in the school the Innovative, Personalized Attention, and Learning Systems, or i-PAL Systems® for short, which is a student-centred educational platform based on some of the best educational practices in the world for the new millennium. It is oriented to maximize student's performance in all areas in order to assure a balanced development: wellness, technology-multiculturalism, academics, fine arts, and sports.

Infrastructure

The AIM was the first school in Monterrey to have a computer lab at the primary/secondary level. The use of technology is part of the school's philosophy and nowadays technology is integrated in daily school life. Each classroom is equipped with a video-projector with audio equipment. Each teacher has a personal laptop supplied by the school so that he or she can integrate technology with teaching and learning within the curricula. The school's technological infrastructure is wireless in order to assure connectivity of all technological devices for continuous access to digital content from the servers and internet.

On the campus that houses students from pre-kindergarten to third grade, all classrooms are equipped with laptops and mobile devices such as iPods and iPads, so that students are assured access to equipment that supports the teaching-learning process. On the campus that houses students from fourth grade to ninth grade, students are required to bring their own iPod/iPad/iPhone to school for learning purposes. In addition, there are mobile labs equipped with laptops that are used upon demand in the classrooms.

Each campus has two full computer laboratories. The classrooms are equipped with tables and chairs that can create a flexible learning space to accommodate whole class instruction, as well as students working individually, in pairs, or in small groups, according to different learning objectives and learning styles. And as technology changes rapidly, there are "techno coaches" who, in addition to teaching technology classes, are responsible for training teachers to use technology for different educational purposes.

Technical Support at the School

Technical support is an integral component of the services provided by the IT Department at AIM. The support provided ensures the proper functioning of all electronic devices, operations of different modules of the school technological platform, connectivity, and access to content via the data network.

The IT Department consists of ten people, four of whom are outsourced externally. It includes the following six key positions:

1. Technology Director, who is responsible for Information Technology and Educational Technology;
2. Technology Coordinator, who is responsible for Information Technology;
3. Information Systems Supervisor, who is responsible for programming;
4. Network Manager, who is responsible for the infrastructure; and
5. Technical Support (one person on each campus, two in total).

The following positions are those outsourced externally:

1. Programmers (three in total); and
2. Servers Manager (for all operating systems: Windows, Linux and Mac)

The technology teachers also serve as Technology Integration Coaches and can provide technical support for common troubleshooting problems.

Use of ICT in the School

In the following pages, we will present a few examples to allow readers to have a concrete idea of how ICT is used in teaching and learning in the school.

Using iPads in the Classroom – Grade Four

In August, 2013, a teacher of the fourth grade employed iPads in his teaching in the classroom. He identified four ways that iPads can be used: 1) for instruction; 2) for assessment; 3) for differentiation; and 4) as a resource database.

Examples of the way in which iPads were used for instruction are that the teacher used Prezi to create non-linear presentations, and students could use QR codes to scan for information. To use iPads for assessment, he employed Nearpod to insert quizzes into the presentations, Socrative to create a quiz and to get immediate results, and Padlet to create a virtual bulletin board to see what students have learned. To deal with the variety of students, iPads were used to have students draft journals, collaborate to create a drawing, compose a song, write and illustrate a story, and explain and record their thinking on a virtual whiteboard. iPads were also used for the storage of resources such as digital books and dictionaries, and for the creation of digital flashcards and digital portfolios.

Learning about Healthy Living – Grade Three

In a third grade classroom, 9- to 10-year-old students learned about healthy living, including healthy habits, safety rules, and growth. As part of the assessment process, students had to create a timeline to show their growth from the day they were born up to the present day. In the timeline they expressed how they had changed physically and mentally in terms of their growth in knowledge and abilities. While in previous years they were given the same assignment to be completed on a piece of cardboard, this time around they were given the option of creating a digital timeline using the iPad Timeline app. Since they did not have a formal lesson for learning how to download pictures to iPad, they had to figure everything out by themselves. In spite of this, all students chose to go the digital route.

Despite the fact that they could not ask for technological support from the teacher, all students were able to come up with a great work. Within the period of one lesson (40 min.), the first work was finished. Students who were struggling to download pictures to their iPad soon discovered that it was easier to take pictures of their physical photos, and using those digital pictures they were able to move on to the writing process and the creation of their timelines.

Technology in Mathematics – Grade One

Number Sense is a strand covered across all four grading periods throughout the school year at AIM. One of the learning objectives covered is to add on and take away 10s (ten or its multiples) to given numbers. This example demonstrates how students utilized various technological means to practice mental mathematics, perform number sense addition and subtraction, and improve their technological learning skills.

Following a lesson opener from the Nelson Mathematics materials, students were first asked to count up and down in 10s and 5s, from 0–100. Projecting a 100-Chart through the Key Note application on the Mac laptop, the teacher would then call out any given number and ask for various volunteers to come and circle the correct answer (+10 or –10) on the whiteboard. The teacher had great flexibility to differentiate even at this step of the lesson, being able to ask for multiples of 10 (+20 or –20) from medium-ability students, or multiples of 5 (+/–15, 35, 45) from high-ability students. In small groups of 4 to 5 students (one iPad per group), the teacher called out any given number, but this time students wrote their responses on their iPad using the Popplet App. To motivate students and enhance their mental mathematics ability, the first group to hold-up their iPad with the correct answer would receive a group point.

After the guided teaching steps described above, students were asked to complete independent work. In conjunction with the Nelson Mathematics lesson activities, students were asked to complete four questions to demonstrate their skills (+/–10 or 20). The low-ability students were asked to complete this activity on the Nelson Mathematics activity worksheet and the teacher provided them with assistance if necessary. The medium-ability students were asked to answer the four questions in their mathematics workbooks, as well as to create their own (+/–10) questions. The high-ability students were asked to complete the activity questions using the Popplet App on iPad independently. Students could then export their works by PDF and email them to the teacher at the end of the lesson.

Students enjoy completing their learning tasks using technology, as if it were an intrinsic motivator in and of itself. There are also great benefits for the teacher. For example, there are checkmarks located on each Popplet box, so that the teacher could mark students' works directly on the Mac laptop using the Adobe Reader application. This application also enables teachers to add their initials and/or signature, which can then be edited directly on the student's PDF. Furthermore, the teacher has the opportunity to add comments directly on the PDF. The teacher can add a "STAR" comment, identifying a positive remark in relation to the lesson learning objective, as well as a "BTB" (Better Than Before) comment, identifying an area of improvement.

International Connection

Being an American School in the country of Mexico, AIM is an International School, with continual opportunities to tie global citizenship connections into its weekly lessons. Preparing students for the 21st century world of employment means setting students up with knowledge and skills they need to succeed in a competitive worldwide community. At AIM, teachers take as many opportunities as possible to combine cross-curricular learning objectives with internationalism, helping students learn as much as possible about the global world around them.

In another example, the Key Note application was used to pre-plan a mathematics lesson where learning to identify and create symmetry was the learning objective in Grading Period 2 for the Geometry Strand. With Egypt as the international country, the teacher chose the Tutankhamun Pharaoh as the symmetrical object. Showing different examples on the Key Note, masking half of each of the examples with an inserted square object, students were asked to take a piece of white A4 paper and copy half of the Pharaoh's death mask onto half of their piece of paper using paint.

Students were then asked to fold the paper in half to see how symmetry is created. In addition to the Pharaoh, they could employ other historical figures from the international country to complete the symmetry task. Their final products were hung on the Egyptian Flag wall display, as part of the historical international link and learning.

In addition, since identifying, writing, and using fractions is one of the learning objectives in the third Grading Period for the Mathematics unit of Algebra, in another example, students were asked to read the Fraction Flags story online through YouTube. Then a student volunteered to come and draw the Egyptian flag on the white board and partition it into fractions according to its colours, writing one of the fractions on the board. Other volunteers were then asked to come and write the fractions for the other two colours of the flag.

Students were then divided into small groups, each group having one iPad. Students were distributed worksheets and used a search engine or the Flags App to conduct research on the flags of six different countries. Then, they demonstrated their mathematical fraction skills using those flags. Members of each group were excited and engaged in the task. Many of the students could even connect the flag of their favorite soccer team's country and the players.

At the end of the activity, the iPad Camera App was used to take the photo of a completed worksheet, which was used as an example for the whole class to follow and further revise their own work. The student whose worksheet was used reflected on her work using the Reflector App on the teacher's Mac laptop. The teacher marked corrections with a black whiteboard marker. Students then corrected their own worksheets with a marker of a different colour and self-assessed their learning objective using the smile-face system for understanding. Finally, the teacher displayed each student's worksheet on the wall outside the classroom for the whole school to see and for students to take pride in their work. This is an example of how technology can make the class facilitation easier and maximize the real-time teaching-learning contact.

Limitations and Concerns

This section presents the major limitations and concerns of using ICT in the school. First of all, to have a proper infrastructure for servicing so many laptops and mobile devices is a big challenge at AIM, especially in terms of connecting them to the network because they use different communication protocols. A very detailed analysis of the configuration of roaming and of the networks is necessary in order to assure that the radios of the access points are configured with all the protocols.

Another challenge has to do with teacher training. Several training methods have been used, including organizing training sessions in large groups as well as small groups, and training has been provided by the Information Systems team as well as by the educational technology teachers, who are also the technological coaches for their peers. The last method is found to be more successful because the teachers are more attuned to classroom teachers' needs. Each teacher receives a 40-minute training session per week, where more personalized training is held in a technology literacy programme that is aligned with the learning objectives defined by the school, and in which the techno coaches aide the classroom teachers in using technology in their subject areas. In addition, technology sessions are held during the four professional development days held at the school.

The third challenge is related to budgets. Since the pace of technological innovation is so fast, the learning objectives are constantly evolving and, therefore, the need for up-to-date technology is paramount. But the budgets are always limited. The school has looked for many sustainable solutions to address the problem of technological obsolescence. A three-year leasing programme has been opted for, which will allow the evaluation of the needs and offer solutions aligned with the technological objectives.

Changes Inside and Outside the School

Everything has changed since ICT started being integrated into school education 27 years ago: students have evolved, teachers have evolved, parents have evolved, and the world has changed dramatically. Educational systems have to keep pace with this ever-evolving world.

At AIM, though, there is a basic understanding that technology is the key element in transforming education from the traditional model to a more interactive, hands-on, student-led, product-oriented, and exciting learning experience. Through technology, the world not only becomes smaller but it comes alive in the classroom.

Initially students used productivity tools, which has already been a massive leap forward. Suddenly, students have the power in classrooms to do the things their parents do at work. Moreover, students have begun to do programing using Logo, and they make animated graphics with routines and subroutines. This helps them not only understand the syntax in a command, but also think more logically.

In technology classes, as students have different levels of knowledge and skills that depend on the availability of hardware and software at home, teachers have learned to respond to the needs of students in order to keep them engaged.

The technology teachers are mentors for the students, as they help to promote student learning beyond the teachers' own level of expertise. They also recognize that they have much to learn from the students. The technology teachers exemplify the role of teachers as lifelong learners, as technology evolves from year to year and teachers need to keep abreast of the changes or otherwise become obsolete.

Technology plays a key role in the development of interdisciplinary projects. Teachers must ensure that students use technology applications for all school subjects. When the Internet and email accounts became available within the school, research and communication skills exploded, and the borders between the country and the world suddenly disappeared as well. The entire school community —teachers, parents and students— could communicate more efficiently now. In a few years, the school has become paperless for communication.

With the information explosion on the Internet, students have to learn to become more critical of the information that is available to them and must be able to recognize whether the sources are credible. On that note, there should also be a focus on having students learn to credit their sources and avoid plagiarism. Students are also emboldened, through the internet, to contact experts in the fields of science, history, politics, literature, and others in order to seek out knowledge and expertise for contributions to school projects.

A greater understanding of other cultures and current affairs in the world is also a result of the students' use of the internet, as they participate in multicultural projects with students living in other parts of the world.

The level of their programming skills have also grown exponentially. They create websites and design robotics using Lego. Desktop publishing and multimedia tools transform the look of students' works and projects, as well as that of teacher-prepared materials. Technology also has a significant impact on the subject of the arts, as students use different software and applications for composing and playing music, for graphic design, etc.

The uses of mobile and handheld devices to store and have access to information —whether from the Internet or from resources prepared by the teachers—, as well as the myriad of apps for skill-development and practice allow students to have academic resources at their fingertips 24/7, within and outside of school.

To bring about all of these transformations, teachers at AIM are cultivating a rich learning environment, promoting student-initiated research, and encouraging discussions and projects across all disciplines.

However, not all the changes are good. It has become evident that students are losing their innocence at an earlier age, and bullying has been magnified through the use of social networks.

Crucial Factors Leading to All These Changes

To bring about the above changes, the following factors are crucial:

1. The AIM Administration strongly supports the integration of technology into education throughout all these years.

2. The Parents' Association is visionary in supporting technology financially through the establishment of a mandatory technology fee for incoming students, which allows the school to keep pace with technological equipment.

3. The technology teachers are driven by the belief that technology is a backbone of the educational system and continue to keep abreast of technological innovations.

4. The Information Systems department provides the evolving infrastructure needed for the school to keep pace with the technological innovations and helps to trouble-shoot the never-ending complexity of technology for a smooth operation of hardware and software.

5. The technology teachers and Information Systems department provide exemplary professional development for the teachers with each new innovation introduced to the school. They take the teachers "by the hand" so that they are comfortable to learn new technological skills and applications.

6. The students have access to a wide variety of technological tools and gadgets, which is important for triggering the changes.

Chapter 5

Primary and Lower Secondary School Bošany, Slovakia

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The school in Bošany is a state school situated in the central part of Slovakia, about 140 kilometres from the capital, Bratislava. Bošany is the second largest village in the Partizanske district, with a population of 4,300 people. Besides serving students in Bošany, the school works as a catchment school for two neighbouring smaller villages as well. The whole district has a relatively high rate of unemployment (over 12%), which influences the social status of its inhabitants.

The history of Bošany can be traced back to the year 1183, with the first historical mentioning of a local school in the 15th century. The present building that the school inhabits was built in 1961. Funded and operated by the village, the school is situated in an impressive park, comprising of two separate buildings and a gymnasium, with primary classes located in both buildings.

The school provides four grades of primary and five grades of lower secondary education —the most common model of Slovak compulsory education— and serves students with ages between 6 and 15. The total numbers of students and staff are 350 and 25, respectively. Nine teachers are responsible for the nine classes of the primary stage, with two or three classes in each grade, and there are 170 primary students in total. Besides the regular classrooms, there is a specialized art classroom, a Slovak language classroom attached to the school library, a foreign language classroom, two computer classrooms, a training kitchen, and a music classroom, which are shared by both primary and lower secondary classes. The average number of students per class in the primary stage is between 17 and 22. Each primary classroom is equipped with an interactive whiteboard (IWB) and other digital technologies.

The primary teachers have founded a local folklore museum on their own initiative. The museum is located in the lobby, in front of a group of four primary classrooms. Teachers, parents, grandparents, and other local inhabitants are constantly extending its collection.

Figure 5.1 School museum of the local folklore

The vision of the school is to provide a modern education for all students, so that they have a greater chance to be successful and content both at school and in their future lives. The school has a mission to educate and raise students with well-developed personalities, students who have their own dreams and are prepared to struggle for them. Although modern digital technologies are used, traditional values like respect, freedom, and responsibility are also emphasized in the school. The school has its own educational programme named "Active School," which focuses on active learning, so that students can be agents in creating their own knowledge by exploring and discovering, looking for solutions, and learning through projects, games, activities, and contests. The programme emphasizes that students should learn mostly at school by suppressing passive learning and school duties at home in the evenings. The school also systematically strives to get parents and the local community to be involved in the school life.

Starting from the first grade, the school gives a high priority to the subjects of English (the first foreign language) and Informatics (a compulsory subject in Slovakia), as well as it prioritizes productive integration of technologies into teaching and learning in all subjects. In Informatics and English lessons, the class is always divided into two groups, each with about eight to ten students. Special classrooms equipped with computers and a data projector are usually used for these lessons. Additionally, primary students may take part in an after-school computer club.

The school has thoroughly devoted itself to integration of digital technologies into teaching and learning since 2001, when this process was initiated by the deputy Konturova, who is now the headmistress. The headmaster at that time supported active colleagues with new perspectives and innovative ideas, and so made the school embrace the whole process of integration from its beginning until he retired in 2008. In 2001, Konturova participated in a national InfoAge conference for primary and secondary teachers, and got inspired to take first steps of the innovation. Gradually, more and more colleagues joined her.

Based on this initiative, the school started gathering experience and winning participation in national and international projects, including Partners in Learning (Microsoft), Smart School (Samsung), Notebook for every pupil (Microsoft), Universal Curriculum, and various national initiatives to support the development of digital literacy, among others.

Figure 5.2 A group of students kneeling around the notebook, solving a project task

Use of ICT in the School

Teachers of the school, inspired by their headmistress, believe that the purpose of primary education is broader than teaching students to read, write, and do arithmetic. They realize that other competencies, such as digital literacy, are becoming just as important. Digital literacy helps students learn better, communicate and collaborate more effectively, succeed in the labour market, and live comfortably in a digital world.

Since computers have become part of students' everyday lives, traditional instruction focusing on the transmission of knowledge is not stimulating enough anymore. Something had to change, and ICT seemed to be the ideal means of change, since it promised to make teaching and learning more attractive. At first, teachers grasped the potential of new technology only partially. Pioneer teachers who began to use ICT quickly gained experience and, with it, the appreciation from their students and respect from colleagues. Teachers who joined later had the advantage that the technology was already more common, advanced, and readily available. These teachers were able to innovate their teaching more quickly and would not commit the initial mistakes.

Teachers in Bošany believe that ICT should be used in the school in two different ways simultaneously: as a means of student learning and as an instrument for effective teaching. In both cases, ICTs are excellent assistants for teachers, enabling them to teach students to discover the world, communicate, and get information for sorting, processing, and presenting. ICTs also enable teachers to improve their teaching by making it more diverse, interesting, hands-on, modern, and more available for people such as parents.

There are various scenarios under which teachers can make use of ICT in teaching. When students work individually, they usually get a digital worksheet prepared by the teacher in the format of MS Word. After a short instruction by the teacher, students can work at their own pace and complete the assignments in any order.

Sometimes teachers let students of different ages work together. For example, students of the ninth grade (the "notebook" class) might create fairy tales in the context of attention and comprehension development for the first graders, who might answer questions using clickers.

Another example of cross-age activity is Spooky reading, in which students of the first grade come to school together with their parents in the evening. Teachers and older students prepare reading tasks which have to be completed using notebooks or interactive whiteboards.

At school, students are encouraged to bring their own digital cameras, tablets, e-book readers, and other digital devices. Interactive whiteboards are used on a daily basis; students spend half of the classroom time working with them. Visualizer is used at least during one lesson each day. The computer lab is almost always booked, particularly for the Informatics class, but also for other classes. Students work at least once a month on projects using their notebooks. Digital cameras are used as needed at various lessons. Digital programmable toys Bee-Bot are used in every classroom twice a month, usually during reading and science classes. Tablets are used twice a week, especially in mathematics and science classes.

Figure 5.3 Students of the 1st grade use clickers on a regular basis

Improving Reading Comprehension with Digital Technologies

In a first grade class, the teacher used digital technology for developing students' reading comprehension, as it is highly motivational even for the youngest students. The teacher made use of students' knowledge in Informatics to prepare assignments and exercises for reading comprehension using the following applications:

- In MS Word, she prepared a worksheet on reading comprehension consisting of interesting and motivational exercises, problem-solving tasks, fill-in puzzles, and word-finding puzzles. Students opened the worksheet on their notebooks.
- In MS PowerPoint, she created slideshows with information of writers and their literary works. A slideshow is exceptionally appropriate for presenting extracts from literary works, as texts can be accompanied by illustrations, animations, recorded reading footage, video, or hypertext.
- Applications such as MS Paint, Revelation Natural Art, and TuxPaint were used for the development of students' creative writing and reading.
- In The Cards (an application that will be explained later), she created fill-in activities that could be used to develop reading comprehension.
- She also used the application Hot Potatoes, with which she could build five different types of tasks: multiple choice questions, yes/no questions, questions with short answer, sentences with wrong word order, and fill-in tasks. These tasks are excellent aid during reading lessons. They allow students to work individually according to their own speed.

Students learned to work in pairs and to search for required information in the text. The teacher had enough time to pay attention to weaker students while others were working on their own. After reading the text, students filled in the worksheet using their notebooks. Skills such as underlining words, changing font size and colour in the text, using the mouse, saving documents, and drawing illustrations accompanying the text, became routine for students. Their typing skills also improved with time. Switching among various tasks could prevent students' boredom and keep them interested. Students could repeat a task several times over, or go back a few steps and think. The teacher was pleased by students' positive reactions. While switching among tasks, students did not even notice how actively they were working with literature.

Collaborating with Parents and Grandparents

In the Bošany Primary School, it is important for everyone to strive to develop relationships with the whole community, including those with parents and grandparents. As remembered by one of the teachers, when she was a child her grandfather talked about the wooden boards they used in the school, on which they wrote with a piece of coal. Nowadays there are notebooks, computers, and interactive whiteboards. Many years have passed but some things remain the same – the lives of children and their grandparents are knit closely, embedded in a community.

Grandparents often substitute for parents when the latters are too busy with their jobs. Grandparents help their grandchildren with homework and learn together with them. However, normally they miss the opportunity to get familiar with the daily school environment of their grandchildren. Some time ago, the teachers decided to make that happen. During the "Respect the Elderly Month", the second grade students brought their grandparent to the school. Along with the visit, the teachers organized an exhibition of items of daily use from the past. The exhibition was prepared by teachers, students, and other school employees. The showpieces familiarized the students with folk tradition and brought back the old days of the grandparents. Grandparents and grandmothers were invited to the classrooms to see how their grandchildren learn. They had heard about interactive whiteboards from the children and couldn't imagine how they really work. Students were proud to teach their grandparents to use new modern technology and explained them how to use the whiteboards during the lessons. The grandparents tried to use the whiteboards themselves and also shared with students how they learned in schools when they were young. Everyone enjoyed the visit and all agreed that school is much more entertaining and interesting these days.

Figure 5.4 Students teaching their grandparents to use the interactive whiteboard

Developing Computational Thinking

In a second grade class, students played with a programmable toy Bee-Bot. At first they played with the toys intuitively —that is, by trial and error. They built hideouts, parking lots, and tried to program the Bees to get to a designated place. At this stage, the teacher just helped them fill in a few blank spaces, and hence the students were discovering how the toys worked by themselves. After the initial lesson, the teacher prepared a mat for Bees to move on. During the reading lesson, the Bees were used to help the students read carefully and understand the text. In addition, the Bee-Bot toy can help the students develop algorithmic thinking, logical thinking, and various skills such as learning how to work in teams.

At first, students used pen and paper to take note of the commands. One student moved the Bee-Bot on the mat; another one in the group decided which command to enter to make the Bee move along the track. Later they worked in groups to play a game of riddles. First they noted a sequence of buttons to push on the paper and the other group guessed the path of the Bee. After making the guesses, they checked if the other group was right by entering the commands and releasing the Bee. The biggest problem was working with the turning commands, since students expected the bee to move to the next field as well. However, they soon discovered that another command was needed to move the Bee to the next field. The teachers didn't even notice when and how students established their own system to program the Bee without pen and paper. They moved the Bee over the mat and simultaneously they pushed the buttons. All worked well, and they had a lot of fun with Bee-Bots, which have been used many times during various lessons. When they play with them, they don't even realize the vast amount of skills and knowledge they have acquired. Even the weaker students experience success.

Figure 5.5 Digital programmable toy Bee-Bot for developing reading skills

Supporting Conditions for ICT Use in the School

The School Leaders have a Clear Vision of the Integration

The headmistress creates and maintains an open, creative, and collaborative atmosphere. She is interested in the latest trends in education and possibilities of ICT integration, and understands their significance to the development of students' cognitive processes. She is a role model for her colleagues, who are inclined to adopt her attitude and views. "The richness of our school lies in our teachers", she adds. She does everything she can in order to equip every classroom with modern technology and encourages teachers to develop their skills, prepare innovative activities, and focus on creative student-oriented teaching.

The school leadership makes sure that both teachers and parents of students understand the potential of ICT. Without that understanding, the process of ICT integration cannot develop successfully.

The Integration has become One of the Instruments of a Holistic Transformation of the School

ICT integration in the school has been a complex transformation involving all teachers, students, and school subjects, and is a part of a holistic transformation. This holistic transformation aims to create an educative space of humanistic values with a creative and optimistic atmosphere in order to stimulate the joy of learning, trigger a sense of responsibility for students' own development, and support quality education and good relationships.

The school leadership is aware of a particular "paradox": even though the school in Bošany belongs among the best schools regarding ICT integration, the scores in national external testing of final graders' knowledge are only average. Nevertheless, the leadership together with teaching staff believe that their approaches are beneficial to the students, and the added value of ICT integration cannot be measured by standardized tests. That value can be seen in students' eagerness to learn, their developed communication skills, their self-confidence, and their 21st century learning skills.

The Students and their Learning Processes Constitute the Main Goal of the Integration

The use of ICT to support cognitive process is only one part of the wider changes that have been taking place in education during the last few decades. The centre of attention has shifted to the students and their needs. In this student-centred education, there are new or modified educational objectives, a new role for the teacher —to be a partner of the student in the learning process—, new forms of evaluation, new competencies for the 21st century learning, and new pedagogies. The presence of ICT neither causes these issues, nor has been their result.

School leaders and teachers in Bošany perceive the process of ICT integration in this broader context, and they try to look for technologies and practices that will help them both reflect on new and changing educational goals and succeed at achieving them. They believe that with ICT they are able to make the educational process more efficient, interactive, visual, and thus more attractive to students. During the lessons, they use a variety of digital technologies and materials that increase the interest and motivation of students, including those with learning difficulties. They can also make the foreign language classes more efficient as they can present the language in an authentic context.

The School is Being Converted into a "Continuous Learning Environment" for All, Including the Teachers

One of the objectives of the holistic transformation of the school is to create an attractive and stimulating learning environment for all participants in the process: first and foremost, students, but also teachers (and, indirectly, parents and other community members). School leaders and teachers realize that just like they have been evaluating students, students constantly "evaluate" them by observing whether they educate themselves, integrate new approaches to their teaching, and use new technologies.

An important part of teacher education is continuous development of digital literacy. A "Modern Teachers' Club" has been set up in the school, so that teachers can meet regularly to discuss the novelties they've seen in conferences and other events. They help each other deal with obstacles, they inspire each other, and they learn how to use new software. Teachers actively participate in various discussion groups on Facebook and on www.zborovna.sk —the portal for teachers. They give lectures in conferences, where they share their experience with other teachers. In one international activity, they spent a few weeks in Kenya, training local teachers to integrate ICT into education.

All Teachers are Innovative, Active, Undaunted, and Creative

Teachers in Bošany constantly search for new forms of ICT integration in order to fulfil educational objectives in a safe, attractive, and effective way. They create and apply these methods; then they constantly discuss and observe their influence on students; finally, they evaluate, modify, and improve them. A large portion of the digital content they use has been made precisely by them. They create presentations for students, use different software to prepare worksheets and tests (with students solving them with clickers, for example), and make texts which can be delivered by the LMS system. They also search for different educational activities and programs on the internet, and eagerly use an authoring environment called "The Cards" to create digital interactive activities for students to fill in gaps, search for objects and classify them, and pair them up. The portal for teachers (www.zborovna.sk) contains a few thousands similar activities created by teachers and available for free. Students enjoy this kind of interactive activities.

Figure 5.6 Interactive activities designed by teachers in an environment called The Cards.

The School Thoroughly Develops Relationships and Partnerships

Teachers in the Bošany School realize that ICT integration brings opportunities for developing new relationships among students, teachers, parents (and grandparents), the school, the local community, and new collaborative relationships with various national and international institutions. These relationships should be systematically developed for the benefit of all those involved.

Teachers communicate with their students via chat on a regular basis. Some projects conducted by the second-stage students are run through the groups set up on Facebook. The first-stage students can also communicate with the headmistress via digital media on a regular basis.

The school also has a positive influence on the students' active use of Internet at home. Parents understand the necessity of Internet connection at home, as it is part of their children's education and allows them to communicate with the school effectively. According to a survey conducted in September 2012, more than 80% of the first-stage students of primary education have Internet access at home. In some classes, the percentage is even higher. For those students who do not have Internet access at home, they can use computers in the afterschool computer club. The survey also confirmed that not only students, but also their parents (80.3%) actively use the Internet at home.

The Teachers Pay Close Attention to the Safety Issues of Students in the Digital World

The safety of students in the digital world must not be underestimated or neglected. Teachers at Bošany primary school are becoming more demanding about the quality and appropriateness of ICT used in the educational process. Currently, for example, the computer classrooms are equipped with height-adjustable swivel chairs to suit the needs of students of different ages. When purchasing new technologies, the teachers take into consideration their weight because students are allowed to take them home or outside the classroom.

Figure 5.7 Figure 5.6. A project focusing on internet safety designed for young people

The school has set the rules for using the Internet, which are part of the official school rules. Teachers organize regular class discussions with students where they try to explain the risks and discuss media news of safety issues in the digital world. They also use a highly popular portal, www.sheeplive.eu, that focuses on Internet safety. Through short animated spots, funny games and tests, students become familiar with potential risks and inappropriate behaviour in the digital world. The portal also offers space for further discussions. These activities are highly popular among students.

National Education Policy and Initiatives

This section presents a short history of the process of ICT integration into primary and secondary education in Slovakia. The case of the Bošany School can be then understood in a broader, more complex context.

The initial basis for the integration was the long tradition of the subject of Informatics (in the sense of Computer Science or Computing) and educational programming. Not later than the year of 1985, a compulsory subject called Informatics was established in every upper secondary modern school. Its learning goals were different from those of ICT subjects commonly found in many countries, with educational programming and some basic concepts of Computer Science being always among them. This tradition is still active. Since 2005, the subject of Informatics was established as compulsory in lower secondary education, and starting in 2008 was extended to all primary schools (starting from the second grade) as well. These extensions guarantee that every student aged between 6 and 15 learns Informatics for at least seven years. As a consequence of this policy, there are Informatics teachers and ICT specialists in every school.

The first step in integrating ICT into teaching and learning in all subjects can be traced back at the intergovernmental Dutch, Czech, and Slovak "Comenius Project", which was initiated and funded by the Dutch government and the Philips corporation between 1991 and 1994. Within the project, dozens of schools were equipped with a computer lab and were provided with continuing professional development programmes together with the development of new original content. In 1995, the initiative was taken over by the Open Society Fund (OSF), devoted to connecting certain percentage of schools to the Internet (until 1999). In that period, schools had to equip themselves with hardware or use the older computers from the Comenius Project.

In 1999, the most influential initiative of this kind was launched in Slovakia: the InfoAge Project (in Slovak, Infovek). It started as an initiative by a small group of academic enthusiasts, and then slowly grew into a national movement supported directly by the Parliament and later by the Government of Slovakia, too. Gradually, more and more schools joined the InfoAge Project, which concentrated on the building of infrastructure, professional development of teachers, and development of new digital content and educational software. Annual national conferences, as well as summer and winter schools, were organized for teachers. These proved to be the initial step towards teachers' enhancement of digital literacy and the whole transformation of schools. The government gradually overtook the planning and decision-making within the project and reduced it mostly to delivery of hardware and connectivity to the Internet.

The Ministry of Education at that time overlooked the importance of professional development and educational content development. Since 2005, they issued several policy documents in this area; however, none of them had any real impact on the everyday lives of schools and teachers. At the same time, in 2005 and 2006, the initiators of the InfoAge Project managed to conduct a new initiative for 1,000 primary and secondary schools (out of a total of 3,300) called "Digital Štúr at School" and funded by The Ministry of Transport. Its goal was to help schools spread their digital erudition into their local communities. Surveys recorded the increased level of digital literacy on a national scale and the promotion of digital content in the non-profit sector.

Within the second programming period (2007-2013) of the European Social Fund (ESF), several national projects were implemented in Slovakia in the context of ICT integration, focusing mainly on the continuous professional development of teachers, including several thousand kindergarten teachers. In 2009, Slovakia joined the European Schoolnet (EUN), a network of 30 European Ministries of Education created in 1997 with the objective of bringing innovation in teaching and learning to its key stakeholders. Many schools in Slovakia are now involved in interesting activities organized by the network.

Since 2005, every school is connected to the Internet, although the capacity of the connection is often insufficient for the present needs. Schools are also reporting large deficiencies in the hardware equipment. The number of students per computer constantly increases, with a ratio of 3.8 in Jan 2013. The number of students per interactive whiteboard is 91. The most alarming situation is in the context of digital content, as its quality is often in contrast to the needs and trends in modern education. A similar situation is repeatedly reported in the area of teachers' continuous professional development in digital literacy, as a result of the absence of a complex and visionary governmental policy in this area. As a consequence, the leading initiatives are often undertaken by both non-profit institutions and national or international IT companies, which may sometimes focus more on their own commercial interests than on the real innovations of learning processes needed by students.

Since the beginning of the integration of ICT into teaching and learning in Slovakia, the leading role has being played by a few of the more innovative schools, mostly due to their visionary leadership, top quality teachers, and intensive collaboration with academic teams, non-profit organizations, and private companies devoted to teachers' professional development and digital content development. Their active involvement in several international initiatives and programmes is also important. These schools, with the Bošany School being one of them, inspire and influence in various ways their local communities and other schools in their regions throughout Slovakia.

Challenges and Way Forward

The headmistress and teachers of the Bošany school continuously analyse and assess the process of integration of ICT and reflect on its further development. One challenge they have encountered is the different levels of computer competencies of students. Students who have computers at home react in a more flexible way to new technologies. Fortunately, more than 80% of them no have computers at home and this percentage is continually increasing. More importantly, however, is the lasting drawbacks in infrastructure, especially the insufficient capacity of the Internet connection, which is evident in occasions such as videoconferences with other schools or partners.

Another serious limitation is the budget. Most of the resources obtained are invested in the infrastructure, but not in digital content or new licenses of educational software. One of the consequences of this (with a certain positive side effect) is that the content is most frequently created by the teachers themselves. The English language interface is also regarded as a problem for some teachers (in higher degree than for students).

Due to the large diversity of technologies at school, sometimes technical problems are encountered. Although the teachers can often fix the problems by themselves, from time to time they have to ask the administrator to come and help. Fortunately, the administrator is always there to offer help promptly, but nonetheless, the problems are disturbing to the course of the class.

The future plan of the Bošany school is to improve both the technical infrastructure and the physical space of the school. The furniture in the classrooms is new, comfortable, and appropriate. However, teachers know that the lighting of the classrooms needs to be renovated. The school also plans to increase the number of tablets considerably so that the "one to one" style of teaching can be extended from the lower secondary to the primary stage.

Thinking back on the whole process of ICT integration, if it could be restarted again, the leader of the school and her team would pay even more attention to the teachers, their professional development, and the equipment they had. The headmistress believes that the teachers should be equipped with notebooks or tablets even before the same technology is deployed into classes. She would also prefer that the transformations in pedagogy or any other field were conducted in all classes of the same grade at the same time. This is, however, usually not possible because of various constraints, including economic ones.

Chapter 6

The Saint-André School, Quebec, Canada: The Project Le Monde de Darwin

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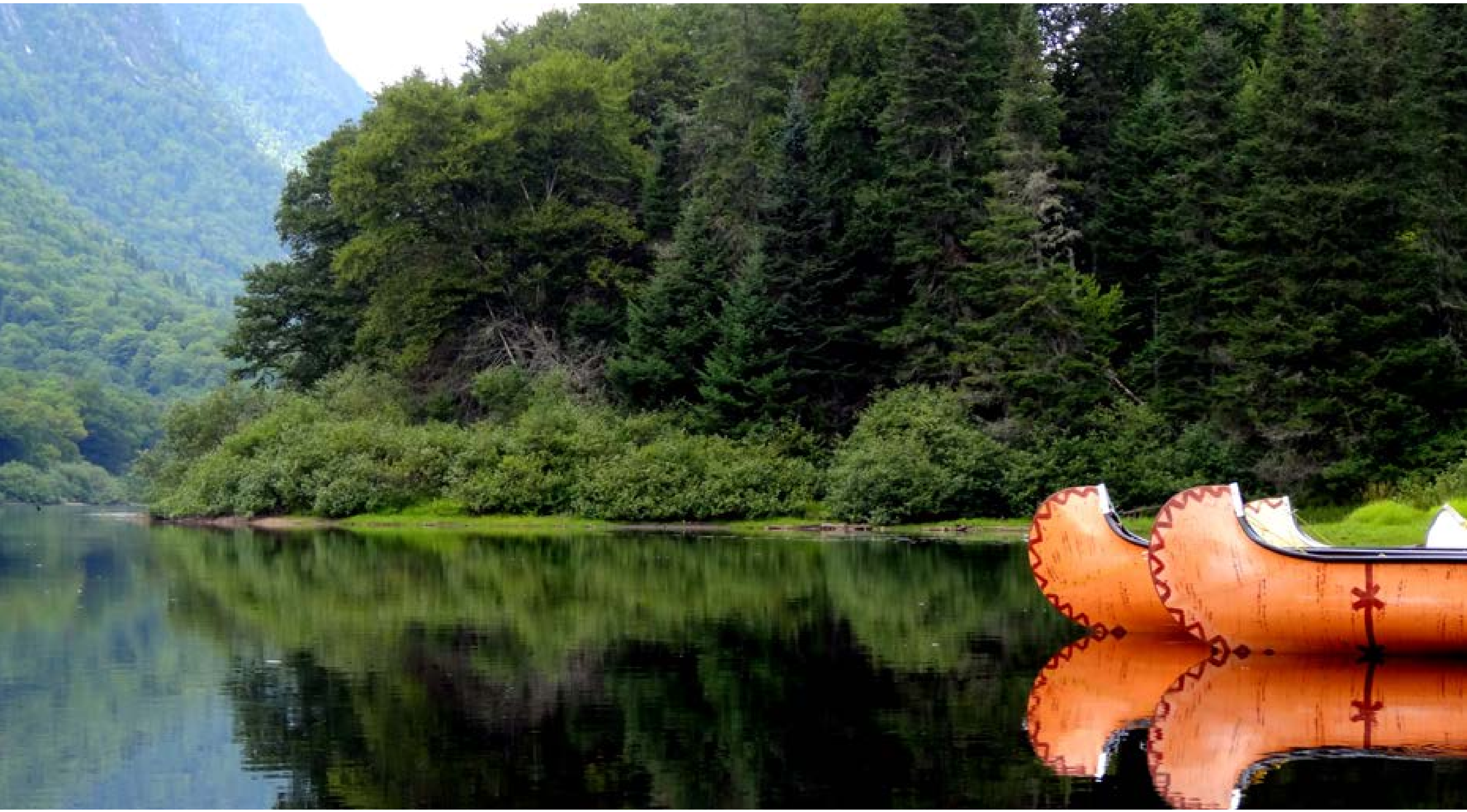

The Saint-André School is a primary school located in Granby, a small city in Quebec, Canada, 100 km East of Montreal, with a population of about 45,000 people. It receives a few hundred students from grade 1 to grade 6. This chapter will focus on the project Le Monde de Darwin (Aubé, 2002; Aubé & David, 2000, 2003a,b; Aubé, David & de la Chevrotière, 2004) that was implemented in the school starting in 1998. The project consisted of a series of school activities aiming at fostering scientific thinking in students aged 9 to 12. In addition to the project website, various sources of information such as books, articles, and integrated field observations were involved in the project. The educational approach employed was deeply collaborative and relied heavily on the critical exchange of data among peers and adult experts. It engaged young students in serious research and emphasized the quality and reliability of information.

When the project was implemented in 1998, the principal and teachers were moderately involved with ICT. Yet among them, three teachers were seriously interested in exploiting computer technologies in their classes – typically word processing, spreadsheets, picture processing, but even browsing the Internet, an activity that was still in its infancy in those years. Although these teachers could only count on two to five computers in each of their classrooms, they showed deep engagement in their work. They were members of a provincial organization, AQUOPS, dedicated to raise and support the use of ICT in primary and secondary schools. The organization held a yearly conference attended by more than a thousand teachers from all over the province, documenting a variety of concrete usages of ICT in education and stimulating rigorous pedagogical thinking about the possibilities offered by technology. Notably, AQUOPS had a research & development (R&D) section that supported new applications with the help of provincial and federal funding. Le Monde de Darwin was initially conceived and developed by a team of three individuals: two university researchers and one primary school teacher from Saint-André (the other two teachers involved in ICT in this school conducted the project in the following years). The total amount of money funded for the six years of its existence was slightly over $100,000, and was spent mainly in hiring computer technicians and graphic designers, though also partially in liberating primary teachers from their regular tasks.

Figure 6.1 Saint-André school in Granby, Québec

Objectives of the Project

The project had a combination of objectives and interrogations: exploiting critically and creatively the technological tools that were gradually penetrating into schools at the end of the 20th century, finding practical answers to the new national curriculum based on competency development (Gouvernement du Québec, 1997, 2006; Le Boterf, 2000; Perrenoud, 1997), learning for transfer (Butterfield & Nelson, 1989; Marini & Généreux, 1995; Perkins & Salomon, 1988), and designing a new approach to scientific education which was more engaging than the traditional way – based too frequently on the passive recording of facts exposed by adults. In the past decades, new visions of learning have emerged, such as metacognitive thinking (Lafortune, Mongeau & Pallascio, 1999; Saint-Pierre, 1994), problem solving, project-based learning (Grant, 2002; Wrigley, 1998), cooperative learning (Johnson & Johnson, 1989; Slavin, 1995), situated learning (Brown, Collins & Duguid, 1989; Greeno, Moore & Smith, 1993), among others. It seemed that ICT offered a good opportunity for borrowing from these visions and bringing them together in a creative way. Yet the proponents of the project insisted that the approach to learning had to be attainable in the classroom by a typical teacher. Hence, the technical aspects needed to be sufficiently user friendly and not require additional training, the content covered needed to be rigorous and consonant with materials to be learned in schools, and yet the results could provide evidence for student engagement in high-level thinking processes.

The Underlying Epistemological and Pedagogical Foundations

The epistemology that inspired the new Quebec curriculum in the late 1990's was the socio-constructivist orientation (Gouvernement du Québec, 1997; Palincsar, 1998). It states that people learn by actively constructing new knowledge from dynamic interactions with the physical and social environments. This does not preclude that we can acquire knowledge by reading books and articles, and from teacher's presentations, since these are also elements and products of the social environment. But the approach stresses that knowledge is basically a means for the coordination of actions, and thus has to be validated and negotiated through continuous interactions with others (Palincsar & Brown, 1984). One way of understanding this approach more precisely is to contemplate how scientific endeavour can be implemented in the most powerful way. The scientific elaboration of knowledge is indeed an example of applying this socio-constructivist model: scientific knowledge does not emerge from the sole observation of the environment, but most critically by submitting facts observed and explanations proposed to the opinion of educated others who question, criticize and eventually validate the new information (Kornfield & Hewitt, 1981; Thagard, 1994). This round of critical exchanges with members of the community is actually the best guarantee of rigor and robustness of new scientific knowledge. The insight behind Le Monde de Darwin was precisely to harness this very idea for the benefit of students' scientific training.

Among all the characteristics of scientific activities, we extracted three main principles. First, as we just mentioned, science is basically a collective endeavour that requires regular exchanges and critical interactions with peers. Scientists actually do their work by getting regularly informed about what other researchers have probed, found, or even discarded. Most importantly, they submit their data, hypotheses, and theories to their colleagues, who confront them fiercely from their own point of view. Scientific facts and knowledge are thus the robust result of this severe round of reciprocal validation. Second, scientists are deeply (and even morally) responsible before society for their own scientific contributions. Products issued from scientific activities (objects as well as theories) eventually percolate through their social lives, and should indeed be validated with rigor and accountability. For example, the chemist designing a new medicine is responsible for thoroughly testing the possible side effects, including lethal ones. Third, scientific inquiry proceeds far more by questioning than by mere answering, because answers, expected or not, typically raise new and deeper questions, that in turn launch new inquiries. Too simple an answer is usually indicative of poor questioning and an unsatisfactorily stated problem. These are the principles that the school wanted students to be concretely and dynamically confronted with. They inspired the design of the website which was at the core of the project. The next section will sketch how we proceeded to meet this challenge.

A Guided Tour of the Project

The website of the project Le Monde de Darwin (http://darwin.cyberscol.qc.ca) offered primary school students a rich and engaging activity called the "adoption program" that could practically last a whole academic year. It challenged fourth- to sixth-graders (9- to 12-year-old students) to choose a wild animal from their local fauna and create on the Internet the best possible card file they could about the identity and ecology of the selected species. The choice was restricted to Vertebrates, and it was exclusive in the sense that a given species could be chosen by only one classroom. Moreover, the animal had to live (and be potentially visible) within a distance of 20-25 km from the school. For instance, the Polar Bear could not be chosen by the students in southern Quebec, and the Hedgehog could be chosen in France, but not in Canada. The idea was to foster students' motivation in their research activities by allowing them to be in the position of being the experts on the studied species, and by giving them the responsibility of presenting rigorous and precise findings about a wild animal from their own surroundings to the rest of the world.

In addition, students had to find at least one good photograph of the adopted species, and to contact a scientist (typically university researchers or governmental experts on the protection of national fauna) who would be knowledgeable enough about the species to validate the information registered. They also had to find another adult fluent in French who could question, help correct, and support the quality of their writings. These two counsellors received instructions not to give away the answers, but to interact with students in a peer-like manner, questioning their errors or imprecisions, suggesting further readings, or even suggesting experiments that may be conducted whenever possible. Good photographs were often obtained freely from professional nature photographers accessible on the Internet, but students had to explain their project thoroughly so as to convince their generous providers.

Students could work on their card file on the computer and add new information continuously, but the file would remain hidden from viewers on the Internet until its content and language had been reviewed and validated. Yet that process was gradual, since the file was divided into sections that could be posted independently. On the adoption of a new species by a given class, three copies of the card file were actually created. Only the third copy was open to the public. The students always worked on the first copy. Whenever they estimated that one section was sufficiently developed, they would submit it to their scientific advisor who had the password to their own web file. Some interactions ensued, changes were made where necessary, and when the content was considered satisfactory, the section was approved, and the validated section was transported to the second copy. Again, when the students felt that their wordings and expressions were of good quality, they advised their linguistic expert and interacted with him/her until the text was approved. The new version was finally transported to the third copy, which was open to the public. These procedures enabled the information on the card file to be continuously modified and augmented by students, with the additions made becoming visible only once they were reviewed and validated.

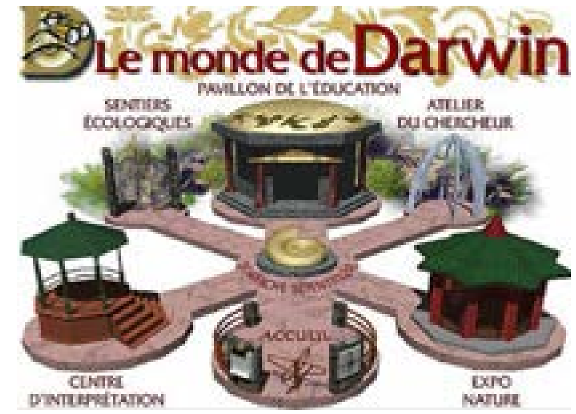

Figure 6.2 Home page of the website

The file had been programmed in a way that enabled students to add information in a variety of formats: texts, tables, photographs, video clips, animation, graphs, distribution maps, hyperlinks (to other sections, to card files of other species, or to various websites), etc. The different sections of the file had been elaborated with the advices from Biologists involved in governmental institutions or ecological associations in Quebec. They covered the questions an expert on a given species of Vertebrates would definitively ask about the animal: its taxonomy, physical description and features, life and reproduction cycles, habitat, family life, predators and preys, typical or peculiar behaviours, usefulness for human activities, characteristics of scientific interest, important research conducted on the species, etc. Once saved and approved, the filled form would be displayed in a neat appearance on the website. Students regularly visited similar files existing on the Internet and quickly appreciated the quality of what they could achieve. This in turn had a convincing effect on the experts about the seriousness of the endeavour, and it induced them to spend significant time interacting with the class through e-mail.

Figure 6.3 Example of a Presentation section

Different tools and guidelines were accessible on the website to help students, teachers, and experts on various tasks along their progress through the project. One special section of the file seemed especially conducive to students' scientific thinking: it was about documenting existing scientific research on the animal of interest, and ended requiring students to formulate at least one interesting question yet unsolved about the species studied. The consideration of whether the question was "interesting" was from the scientific community's point of view, and it could not be addressed without reading books and articles, searching the Internet, and mostly, a serious interaction with the expert scientists. This section was generally completed towards the end of the project, after students had gained a serious knowledge and understanding of all aspects of the species. However, the structure of the file induced their thinking about the "interesting unsolved questions" right from the beginning, this practically sustained their thinking and interest throughout all the sections. For instance, in the first section concerning the presentation of the animal (see Figure 6.3), students were invited to attract the interest of readers by mentioning some very special curiosity about the animal, something so special that it would act as a kind of "trademark".

We captured this phenomenon as the "haaa!" effect, and gave students various examples which invariably induced this surprise reaction, such as the freezing of Gray Treefrog during winter and unfreezing in spring (Storey & Storey, 1985), the Indigo Bunting's using an internal celestial map to insure navigation during migration (Emlen, 1967a,b), and the totally inverted sexual roles of polyandrous Wilson's Phalarope (Hohn, 1969) compared to the monogamous way of life most often encountered in Birds. In other sections, students were invited to contemplate some striking similarities among different species, even of distant genetic families, or to compare various behaviors and their likely effects on the adaptation to the ecological niche. Students thus become accustomed to the enormous variety of solutions that the struggle for life encompassed in biodiversity, and we found that their fascination about this greatly sustained their quest for significant questions as well as their overall motivation in the project.

Examples Illustrating Young Participants' Scientific Attitudes

The project was first experimented in a single classroom during 1998-99, which was accessible openly to other classrooms in the following year, and ended in 2004, mainly for the lack of financial support. All registrations were on a voluntary basis: teachers who had heard about the project (notably at the AQUOPS conference, or from word of mouth) would contact the head of the project and register for the next academic year. In its six years of duration, 15 classes registered in Quebec and 13 in France (informed via communications at conferences in Canada). Each year, the projects generally lasted from October to April. Although most of the students were aged between 10 and 12, a few classes of fourth graders with students as young as 9 to 10 years old performed surprisingly well. Half of the classes involved in the project succeeded in finding an expert with good scientific knowledge with whom they pursued significant interactions for the second part of the project. Coincidentally, about half of the classes also succeeded in raising questions sufficiently complex and interesting to be noted by the experts. The following subsections present a few anecdotes illustrating these interactions from the very first class who had adopted the "Spotted Salamander" (Figure 6.3).

Anecdote 1: A Different Sexuality…

Each of the classrooms involved in the project was usually divided into five teams corresponding to the different sections of the card file (see Figure 6.3): Presentation, Identification, Biological Cycle, Ecological Niche, and Scientific Activities. Each team was responsible for finding the information pertaining to its own section and writing it up in a rigorous and attractive fashion. Regularly, the teacher asked members of each team to inform the rest of the class about the results of their research, and to share any relevant information pertaining to the other sections they might have encountered in their readings. Reciprocally, students were induced to formulate and explain the specific questions they had problems with, and to ask for any relevant piece of knowledge that members of the other teams might have come across.

One day, a little girl from the team working on the section of Biological cycle started a discussion with the observer, a university member of the project. Her team had problems with the form where they needed to specify the species' reproduction mode. Only two choices were offered: mating (as in birds and mammals) and spawning (as in fish). The girl said that her team members had read thoroughly about it, in books as well as on the Internet, without finding which mode was actually used by the animal. She clearly understood that spawning involved external impregnation by male sperm of female eggs laid in water. Mating on the other end involved internal impregnation with penetration, generally after some petting and fondling between the partners. But the reproduction mode of the species they studied, a salamander, seemed to be a strange mix: first, there was some fondling by the male to induce the female to follow him under water, then the male would lay a few cones of sperm on the bottom of the creek and the female would walk over and take them inside her cloaca. This internal impregnation without male penetration was not compatible to any of the proposed choices. The next day, the observer contacted a scientist who was an expert on the Spotted Salamander, the director of the Atlas of Quebec Amphibians and Reptiles (http://www.atlasamphibiensreptiles.qc.ca/). The Biologist was quite amused and surprised, since in two recent conferences on Herpetology he had attended to, a few fellow researchers had actually complained of not having a proper term for the reproduction mode of the Amphibians, and had even suggested mandating a Scientific Committee to state about the case.

Anecdote 2: Where have the Females Gone?

Although members of the class in question already had a knowledgeable scientific advisor, they also sent questions to Dr Ducey, a herpetologist in the United States they found on the web (http://www2.cortland.edu/departments/biology/faculty/ducey.dot). Similar to most of the experts who interacted with the classes in the project, this scientist was fairly generous and frequently responded to the students' inquiries, seemingly impressed by the level of their questioning in general. One should actually consider that these experts are deeply specialized in their domain, and do not often encounter individuals interested enough in their subject to raise significant questions. Various topics were discussed with him, such this salamander's very peculiar behaviour (mentioned in Figure 6.3) of quickly secreting a sticky and encumbering foam whenever attacked by a predator, and the likely reasons for the yellow spots covering the blackish skin of the animal, probably as some form of camouflage. One day, as students were sharing information about their respective sections, they came across a puzzling question concerning the sex ratios in this species. After some discussion and checking out with their sources, they came to a dead-end and decided to submit the problem to Dr Ducey. Transcripts of this exchange are shown in Table 6.1.

Table 6.1 A sample dialog between students and an expert

From : Pete Ducey <duceyp@snycorva.cortland.edu>
To : Classe de Claude <sa602@csvdc.qc.ca>
Date : May 5, 1999 12:35
Object : Re: Question from the class

Classe de Claude wrote:

>Our class is studying the Spotted Salamander and we have some questions to ask you. We have
>read that, during the reproduction period, the ratio of males to females in the reproduction pond
>is often 10 to 1. We have also learned that females do not necessarily all reproduce every year.
>So here is our question. If there are more males than females in the pond, is it because there are
>more males at birth, or simply because only a certain number of the females reproduce each year?

What an interesting question! The answer actually rests upon the following facts:

– females do not all reproduce every year;
– males stay longer than females in the reproduction pond;
– males begin their reproduction cycle at a younger age than females.

It follows from these facts that, if we make an observation on a given night during the reproduction season, most males of the local population are actually present in the pond, while the females could be distributed along four categories:

– mature females reproducing this year and present in the pond;
– mature females reproducing this year but absent from the pond;
– mature females not reproducing this year;
– and finally, immature females.

Have a good success with your project!

Pete Ducey

In a similar fashion, students could easily picture situations where a few girls of the group would be occupied in some tasks outside the classroom at the same time, giving the false impression that the boys outnumbered them. It is interesting to note that the proper answer to the question actually relied on putting together different pieces of knowledge that students already had. It is also relevant mentioning that exchanges such as the one quoted about were delivered in English by the French-Canadian students, which allowed them to improve their learning and performance in the second language as well.

Anecdote 3: The Mystery of the Fourth Specimen…

The forms used in the Identification section required specifying various characteristics of the species, such as color, length (body and tail), weight, longevity, and so on. Students who tried to be very precise and comprehensive in their postings of these features realized that the information about weight appeared nowhere in books, articles, or the Internet. But since they had the opportunity to have four living specimens (brought by one of the university researchers involved in the project) that they raised for 2 to 3 weeks in a vivarium, they were able to easily obtain the required information by averaging the measures directly taken on the animals. They made some astonishing observations when they tried measuring the length, notably the tail length, of the animals. In addition, one student had the idea of counting the yellow spots distributed all over the animals and relating them with the length measures. These creative and ingenious activities led to an exchange with their scientific advisor that is reported in Table 6.2.

Table 6.2 Converging observations from students and experts

From : Ecomuseum <ecomus@total.net>
To : Classe de Claude <sa602@csvdc.qc.ca>
Date : May 25 1999 16:03
Object : Re: Question from the class

Classe de Claude wrote:

>Hello David,
>Last Friday, we decided to measure the four specimens of Spotted Salamander we had in our class
>and try establish some relation between total length, body and tail length and number of spots.
>Here are the observations we came up with:

>Specimen	total length	nose to cloaca	tail length	number of spots
> 1	17.7 cm	9.0 cm	8.7 cm	24
> 2	17.2 cm	8.5 cm	8.7 cm	26
> 3	17.5 cm	8.2 cm	9.3 cm	31
> 4	14.6 cm	7.3 cm	7.3 cm	25

>Results: all salamanders have a tail length roughly half the total length, except Specimen 3 where
>the tail is proportionally longer. Moreover, we noticed some kind of narrowing on two locations in
>its tail which make us think that there might have been a second growth, perhaps after being bitten.
>In addition, the number of yellow spots is clearly greater for that specimen.
>Question: Is it possible that there be a greater number of spots following the tail second growth !

Although I don't know of any published studies on the subject, it does seem indeed, based on personal observations and on those from colleagues, that there is a greater number of spots on regenerated limbs of Spotted Salamanders, be it on the tail or on any of the four legs. These observations have not yet been confirmed in the scientific community, and it seems for the moment quite difficult to explain why the colouring on a new limb would result in a greater number of spots. It might be an artefact due to pigments reorganization as new tissues are formed in the growth of the new limb.

Sincerely
David Rodriguez

These examples, among many others across different classes, show clearly that serious work and a high level of scientific thinking can be achieved in fairly young students, given the right conditions. It is interesting to notice that right from the beginning, students adopted the same standards of quality that they had seen on the best card files they had seen on the Internet, which had generally been created and posted by Biologists who are experts on the species they studied. Another interesting observation is that students compared different sources and vigorously questioned diverging information. To them, it was important to post only credible data and information on a public site, and this seemed to become a real duty for them, one that they often expressed with pride. Moreover, they did not want to bother their advisor too soon in the project for fear that their questions would not be of a level high enough to raise their associated scientist's interest. They felt highly responsible for the quality of their work, understood the necessity of the reciprocal validation of information, and were far more preoccupied in generating good questions than in finding quick and easy answers. Thus, all three principles inspired by the scientific community metaphor (Kornfield & Hewitt, 1981) advocated at the beginning of the chapter were fully met and respected.

Science is Basically a Collective Endeavour

As illustrated in the above anecdotes, the whole functioning of the Le Monde de Darwin project was highly collaborative, involving many different levels of cooperation: no card file could have been developed by a single individual; it was always the product of the collaboration within a whole group. Students worked in teams associated with sections of the file, yet they regularly exchanged relevant information among teams, and any generally useful knowledge (e.g., how to set up and post a distribution map) quickly percolated across the groups. They understood readily that the final output would be the whole file, and found compelled to help each other to achieve the best results. There were also frequent and often bidirectional exchanges between students and their teachers, university researchers, scientific and linguistic advisors, other researchers on the Net, and employees working in zoos, local pet shops, and provincial museums. Students understood quickly that knowledge was a collective property and had to be shared and negotiated" between individuals and groups making use of it (Campione, Shapiro & Brown, 1995; Palincsar & Brown, 1984; Thagard, 1994). They were thankful and respectful for the time that professional scientists devoted to them, and in turn developed generosity in themselves by sharing knowledge with others.

The Scientist is Responsible before Society for his/her Scientific Contributions

When we stated this principle at the beginning of the project before colleagues or at conferences, most of the audience did not believe that it was possible for students of such young age to live up to such a high standard. However, in practice, this principle probably constituted one of the strongest incentives that fostered the achievement of quality in producing the card file. Right from the beginning, students compared their work to the card files already posted on the web and raised their own standards accordingly. They agreed on spending hours rewording their texts, arguing that they felt responsible for presenting the animals of their own fauna to the rest of the world clearly, correctly, and attractively. Their desire to gather the best information possible before releasing it to the world helped sustain their discussions with experts and encouraged them to be prepared before communicating with their advisor. The data they patiently accumulated and aesthetically formatted on the site had to be continuously and rigorously validated, and afterward it ended up being publicly committed on the web. One is tempted to think that students had begun to feel responsible before society for their own learning and for the quality of knowledge they acquired. This certainly appears as a powerful motivational target that education systems all over the world should aim to reach.

Scientific Inquiry Progresses more by Questioning than by Answering

One procedure worth mentioning here is the one through which students made their (unanimous) choice about the species to be adopted at the very beginning of the project, a process that would generally take a few weeks. First, their teacher led them to visit a few card files about animals on the Internet and to comment on their quality in terms of rigor, clarity, completeness, and aesthetics. This allowed them to notice the sites of some nature photographers, from whom they might later request permission for using pictures. At this point, one of the university researchers in the project asked students to suggest species from their local environment that they had a special interest on. Students had to provide evidence that the animal actually lived within a few kilometres of the school and to state the reasons for their interest. This activity had the benefits of recruiting autobiographical memories of relevant and motivating observations (outing with classmates or friends, holidays in family, fishing trips with parents or other relatives, etc.), and of setting the ecological context necessary for understanding wildlife. Students were then asked in class to write the names of their choices on the blackboard, putting each animal in its proper Vertebrate class: Fish, Amphibians, Reptiles, Birds and Mammals. This round helped students think about additional species, which enriched the list for the whole class. Some animal choices were further added when students noticed that some categories of Vertebrates were poorly represented. Across the different schools involved in the project, the list typically saturated around forty species.

After a lively discussion of their interests in studying these animals, students were asked to vote for their preferred species and the top five were kept. The class was then divided into five teams, team with the task of documenting one of these five species and trying to convince the rest of the class to adopt it. They had 10 to 15 days to gather information and present it to the rest of the class. This activity trained them in searching relevant information, not only about their animals, but also about the ecological characteristics of the surroundings wherein the adopted species lived. Following the presentation, students were asked to list some criteria for adoption (e.g., species that are vulnerable or endangered, species rarely observed outside the local territory, species with intriguing characteristics, species particularly useful for human activity, species poorly documented on the web, etc.). All of these critereia was discussed and sorted by students in order of alleged importance. Among these, the idea of being the very first card file posted on the web for a given animal scored highly (many of the species had not yet been documented at that time). A table was then posted on the blackboard with the criteria in the rows and the species in the columns. We suggested that each cell received a score of 0, 5, or 10 according to the relevance of a given criterion for a given species. Students then calculated the sum of scores for each species and chose the one getting the best total score. In all classes visited, students seemed quite satisfied with the unanimous choice that resulted from this elaborated process —a process that had already generated a good amount of knowledge and research strategies among the class.

It is clear from the above documentation that students were more directed to the inquiry process rather than quick answering. The presentation of so many species from their vicinity had already stimulated their curiosity, and the mutual arguing about the various interests each species represented probed them towards further interrogation. The provisory lack of answers was not experienced as a lack of competence, but as a sting to their own interest and curiosity. At the beginning, students were often surprised to realize that adults did not always hold the answers to their questions. Then they progressively seemed to understand that knowledge was not a point of arrival, but the journey itself. Their progressive insertion in the scientific community could be regarded as a case of legitimate peripheral participation (Lave & Wenger, 1991), exhibiting the behaviours and attitudes similar to those documented in studies of situated learning. Young students turned themselves into rigorous researchers by respectfully integrating and criticizing information from a variety of sources, and looking for validation by experts from the scientific community.

Conclusion

The results reported, though anecdotal, seem to point in the right direction. First, it was not obvious that this project would sustain the interest of a whole class of students for every single week across several months. Yet it is important to stress that all the procedures were set up to sustain the motivation: the selection of species being well grounded in autobiographical souvenirs, the constant activation of curiosity fed by biodiversity, the collaborative attitude largely distributed at many levels, the generous and gratifying investment of significant adults in the project, the possibility of contributing to collective knowledge, and a concrete contribution that their peers and kin could easily witness on the Internet. The quality of engagement, the rigor evidenced, and the capability for deep scientific questioning were also remarkable. It also illustrated a reversal of the usual mode of scientific training: much more active, more engaging, and more oriented towards discovery and problem solving. Finally, it gave students the feeling that they could make contribution to knowledge in the process of learning, and thus it gave them a sense of moral duty to have high-quality communication and to put rigor and effort in their own learning.

So, why did it end? The project was launched with a very small budget, as well as a general scepticism about its feasibility. It required continuous support, notably from the computer technician who had to maintain the system practically all the time (consider that there were classes scattered on two continents, in different time zones), but also from the leader of the project who had to answer, weekly if not daily, to a large spectrum of questions from teachers, experts, and sometimes from students themselves. Neither the teachers nor experts had entered the project with previous training on this approach, and the only guidelines were the ones already posted on the website. We certainly underestimated the costs and efforts required. Nonetheless, the project lasted for many years, was spread over two countries in two different continents using technology much less developed than the current one, and it achieved a respectable success and was unanimously praised by everyone who participated —students, teachers, parents, and scientific advisors.

References

Aubé, M. (2002). «Le Monde de Darwin»: Une démarche intégrée pour favoriser l'atteinte des compétences dans l'esprit de la réforme. Vie pédagogique, 123, 41-45. Retrieved from http://collections.banq.qc.ca/ark:/52327/bs22593.

Aubé, M., & David, R. (2000). «Darwin's World»: Hypermedia Technology to Enhance Scientific Thinking in the Kids. In J. Bourdeau & J. Heller (Eds.), Proceedings of ED-MEDIA 2000 : World Conference on Educational Multimedia, Hypermedia and Telecommunications (p. 1212-1213). Charlottesville, VA: Association for the Advancement of Computing in Education (AACE).

Aubé, M., & David, R. (2003a). Communauté de recherche et formation scientifique des jeunes. In C. Deaudelin & T. Nault (Eds.), Collaborer pour apprendre et faire apprendre: La place des outils technologiques (p. 211-228). Montréal: PUQ, Collection Éducation/ Recherche.

Aubé, M., & David, R. (2003b). Le programme d'adoption du «Monde de Darwin»: Une exploitation concrète des TIC selon une approche socioconstructiviste. In A. Taurisson & A. Senteni (Eds.), Pédagogies.net. L'essor des communautés virtuelles d'apprentissage (p. 49-72). Montréal: PUQ, Collection Éducation/Recherche.

Aubé, M., David, R., & de la Chevrotière. P. (2004). «Le Monde de Darwin»: Un dispositif exploitant les TIC pour favoriser le transfert des apprentissages. In A. Presseau & M. Frenay (Eds.), Le transfert de connaissances et de compétences: comprendre pour mieux intervenir (p. 107-132). Québec: Les Presses de l'Université Laval.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. Educational Researcher, 18(1), 32-42.

Butterfield, E. C., & Nelson, G. D. (1989). Theory and Practice of Teaching for Transfer. Educational Technology Research and Development, 37(3), 5-38.

Campione, J. C., Shapiro, A. M., & Brown, A. L. (1995). Forms of Transfer in a Community of Learners: Flexible Learning and Understanding. In A. McKeough, J. Lupart & A. Marini (Eds.), Teaching for Transfer: Fostering Generalization in Learning (pp. 1-19). Mahwah, NJ: Erlbaum.

Emlen, S. T. (1967a). Migratory orientation in the Indigo Bunting Passerina cyanea. Part I: evidence for use of celestial cues. Auk, 84, 309-342.

Emlen, S. T. (1967b). Migratory orientation in the Indigo Bunting Passerina cyanea. Part II: Mechanism of celestial orientation. Auk, 84, 463-489.

Gouvernement du Québec (1997). L'École, tout un programme. Énoncé de politique éducative. Québec: Ministère de l'Éducation. Retrieved from https://aqep.org/wp-content/uploads/2011/12/L_ecole_tout_un_programme.pdf.

Gouvernement du Québec (2006). Programme de formation de l'école québécoise. Éducation préscolaire. Enseignement primaire. Québec: Ministère de l'Éducation. Retrieved from http://www1.mels.gouv.qc.ca/sections/programmeFormation/pdf/prform2001.pdf.

Grant, M. (2002). Getting a grip on project-based learning: Theory, cases and recommendations. Meridian, 5(1). Retrieved from http://www.ncsu.edu/meridian/win2002/514.

Greeno, J. G., Moore, J. L., & Smith, D. R. (1993). Transfer of Situated Learning. In D. K. Detterman & R. J. Sternberg (Eds.), Transfer on Trial: Intelligence, Cognition, and Instruction (p. 99-167). Norwood, NJ: Ablex Publishing Corporation.

Hohn, E. O. (1969). The phalarope. Scientific American, 220(6), 105-111.

Johnson, D. W., & Johnson, R. T., (1989). Cooperation and Competition: Theory and Research. Edina, MN: Interaction Book.

Kornfield, W. A., & Hewitt, C. E. (1981). The Scientific Community Metaphor. IEEE Transactions on Systems, Man and Cybernetics, 11, 24-33.

Lafortune, L., Mongeau, P., & Pallascio, G. (1999). Métacognition et compétences réflexives. Montréal: Éditions Logiques.

Lave, J., & Wenger, E. (1991). Situated learning. Legitimate peripheral participation. Cambridge, UK: Cambridge University Press.

Le Boterf, G. (2000). Construire les compétences individuelles et collectives. Paris : Éditions d'Organisation.

Marini, A., & Généreux, R. (1995). The Challenge of Teaching for Transfer. In A. McKeough, J. Lupart & A. Marini (Eds.), Teaching for Transfer: Fostering Generalization in Learning (p. 1-19). Mahwah, N. J.: Erlbaum.

Palincsar, A. S. (1998). Social Constructivist Perspectives on Teaching and Learning. Annual Review of Psychology, 49, 345-375.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal Teaching of Comprehension-Fostering and Comprehension-Monitoring Activities. Cognition and Instruction, 1, 117-175.

Perkins, D. N., & Salomon, G. (1988). Teaching for Transfer. Educational Leadership, 46(1), 22-32.

Perrenoud, P. (1997). Construire des compétences dès l'école. Paris: Éditions sociales françaises.

Saint-Pierre, L. (1994). La métacognition, qu'en est-il ? Revue des sciences de l'éducation, XX(3), 529-545. Retrieved from http://www.erudit.org/revue/rse/1994/v20/n3/031740ar.pdf.

Slavin, R.E. (1995). Cooperative Learning: Theory, Research and Practice (2nd ed.). Scarborough, Canada: Allyn and Bacon.

Storey, J.M., & Storey, K.B. (1985). Adaptations of metabolism for freeze tolerance in the gray tree frog, Hyla versicolor. Canadian Journal of Zoology, 63, 49-54. Retrieved from http://www.nrcresearchpress.com/doi/pdf/10.1139/z85-009.

Thagard, P. (1994). Mind, Society, and the Growth of Knowledge. Philosophy of Science, 61(4), 629-645. Retrieved from http://cogsci.uwaterloo.ca/Articles/Pages/Growth.html.

Wrigley, H. (1998). Knowledge in action: The promise of project-based learning. Focus on Basics: Connecting Research and Practice, 2(D). National Centre for the Study of Adult Learning and Literacy. Retrieved from http://www.ncsall.net/index.html@id=384.html.

In 2011 the UNESCO Institute for Information Technologies in Education (IITE) launched a project which was focused on the role of information and communication technologies (ICT) in primary education. The goal of the project was to better understand the phenomenon of ICT in the first stage of institutional compulsory education. During all three years of implementation UNESCO IITE cooperated with international expert team headed by Professor Ivan Kalaš (Comenius University, Slovak Republic).

The UNESCO IITE Analytical survey Volume 3: *Collective Case Study of Promising Practices* is a continuation of the first two reports of the Institute's project "ICT in primary education" – Analytical survey Volume 1: *Exploring the origins, settings and initiatives* (2012), and Analytical survey Volume 2: *Policy, Practices, and Recommendations* (2014).

This report was elaborated by UNESCO IITE in cooperation with a team of leading international experts from Canada, Chile, Hong Kong, Slovak Republic, Singapore, and the Russian Federation. The development of the Volume 3 was coordinated by Professor Cher Ping Lim (The Hong Kong Institute of Education, Hong Kong S.A.R.).

This collective case study describes and analyzes the promising ICT-enhanced teaching and learning practices of five primary schools in different regions of the world: Beacon Primary School (Singapore); Educational Center "Educational Technologies" (Russian Federation); American Institute of Monterrey (Mexico); Primary and Lower Secondary School Bošany (Slovakia); and Saint-André School (Canada). Each case study provides a rich description of the context in which ICT has been used to meet curriculum outcomes, and to engage students in the development of 21st century competencies.

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